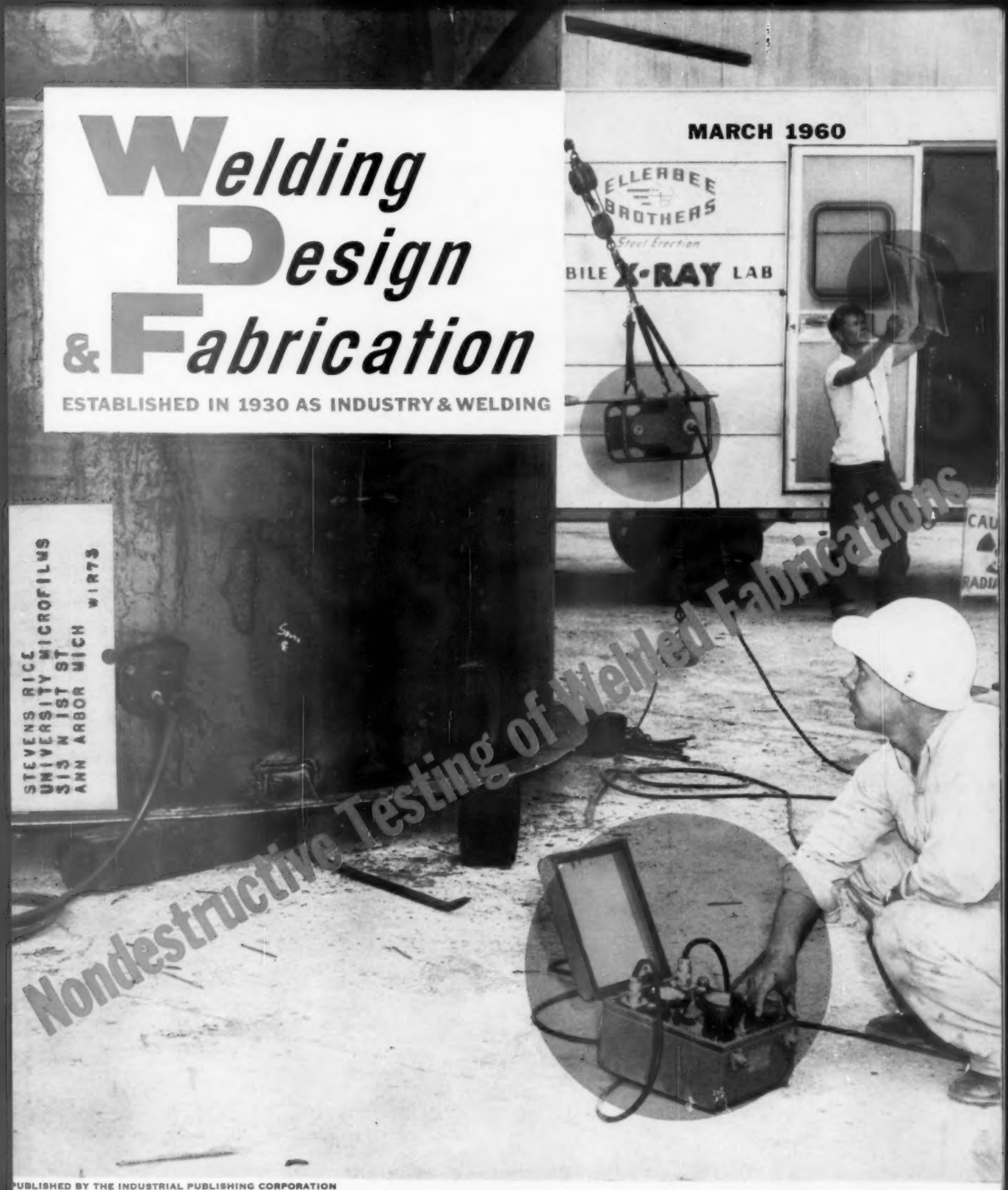
Welding Design & Fabrication

ESTABLISHED IN 1930 AS INDUSTRY & WELDING

MARCH 1960



Nondestructive Testing of Welded Fabrications

PUBLISHED BY THE INDUSTRIAL PUBLISHING CORPORATION

The magazine of welding management, production, and engineering

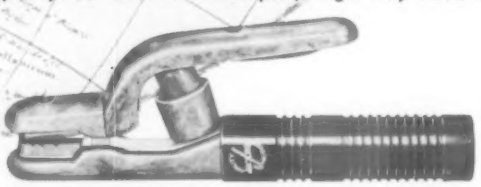
For basic reasons

Jackson *Featherlight* Holders

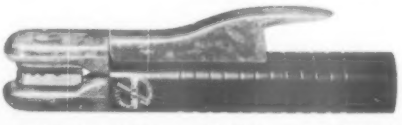
Lighten the welder's load — speed his work. Jackson aluminum-alloy electrode holders weigh up to 35% less, provide durable copper-alloy jaw inserts, and superior long lasting insulators. A Jackson pioneered product — proven good, throughout the world. Select your general duty holders from this Featherlight line.

Jackson Model A-5S, *lightest large-class holder.*
Capacity: 5/16" rods at 400 amps. (weighs only 21 oz.)

Jackson Model JH-3, *medium-class streamlined holder.*
Capacity: 1/4" rods at 300 amps. (weighs only 15 3/4 oz.)



Jackson Model A-W, *lightest medium-class holder.*
Capacity: 1/4" rods at 300 amps. (weighs only 14 oz.)



Jackson Model JH-2, *small-class streamlined holder.*
Capacity: 5/32" rods at 200 amps. (weighs only 9 1/2 oz.)

Sold by better welding supply distributors and dealers everywhere

Jackson Products

AIR REDUCTION SALES CO., A DIVISION OF AIR REDUCTION CO., INC.

31739 Mound Road, Warren, Michigan

For More Information Circle No. 39 on Reader Service Card.

Circle No. 34 on Reader Service Card. ⟶

5 basic reasons WHY A HOBART RECTIFIER WELDER will lower your welding costs

These built-in extras cost you nothing—but they definitely make themselves known by increasing your overall profit. They give you the advantage of higher efficiency, lower maintenance costs, a wide welding range and dependable operation year after year.

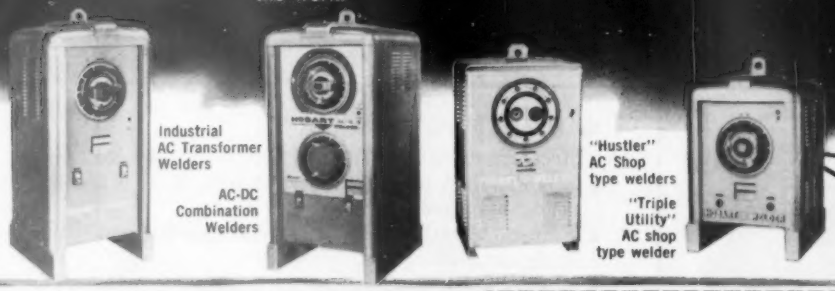
1. NO MOVING CORES or coils in a Hobart . . . it will stay quiet, free of vibration permanently. That is because current control is achieved by an exclusive magnetic field "Diverter Path" principle, the most trouble-free current control method made.

2. AN INHERENTLY STABLE, FLEXIBLE ARC is delivered without depending on boosters or "gadgets," and consequently reduces "down time."

3. "TOP BREATHING" powerful shrouded downdraft fan bathes all internal parts with clean, fresh air—not dust and dirt that can collect under the welder.

4. Both over current and rectifier temperature protection are supplied to provide safeguards against overloads.

5. REMOTE CONTROL of welding current is standard equipment only on a Hobart. Lets you make proper heat adjustments right at the work.



Industrial AC Transformer Welders

AC-DC Combination Welders

"Hustler" AC Shop type welders

"Triple Utility" AC shop type welder

DISCOVER HOW

a Hobart 300 or 400 ampere rectifier can give you fast, low cost welding results. Fill out the coupon and mail it today — without obligation.

HOBART BROTHERS COMPANY, BOX HW-30, Troy, Ohio, 'Phone FE 2-1223.

"Manufacturers of the world's most complete line of arc welding equipment."

THE PERFECT COMBINATION

HOBART **WELDERS** and HOBART **ELECTRODES**

. . . guaranteed controlled quality from raw materials to the finished product. A simple comparison proves their superiority.

HOBART BROTHERS COMPANY, BOX HW-30, TROY, OHIO

Yes, I'd like more information on ____ ampere capacity—

☐ Hobart DC Rectifier ☐ AC Transformer Welder ☐ Combination AC/DC Welders ☐ "Hustler" Small Shop Welder ☐ "Triple Utility" AC Shop Welder

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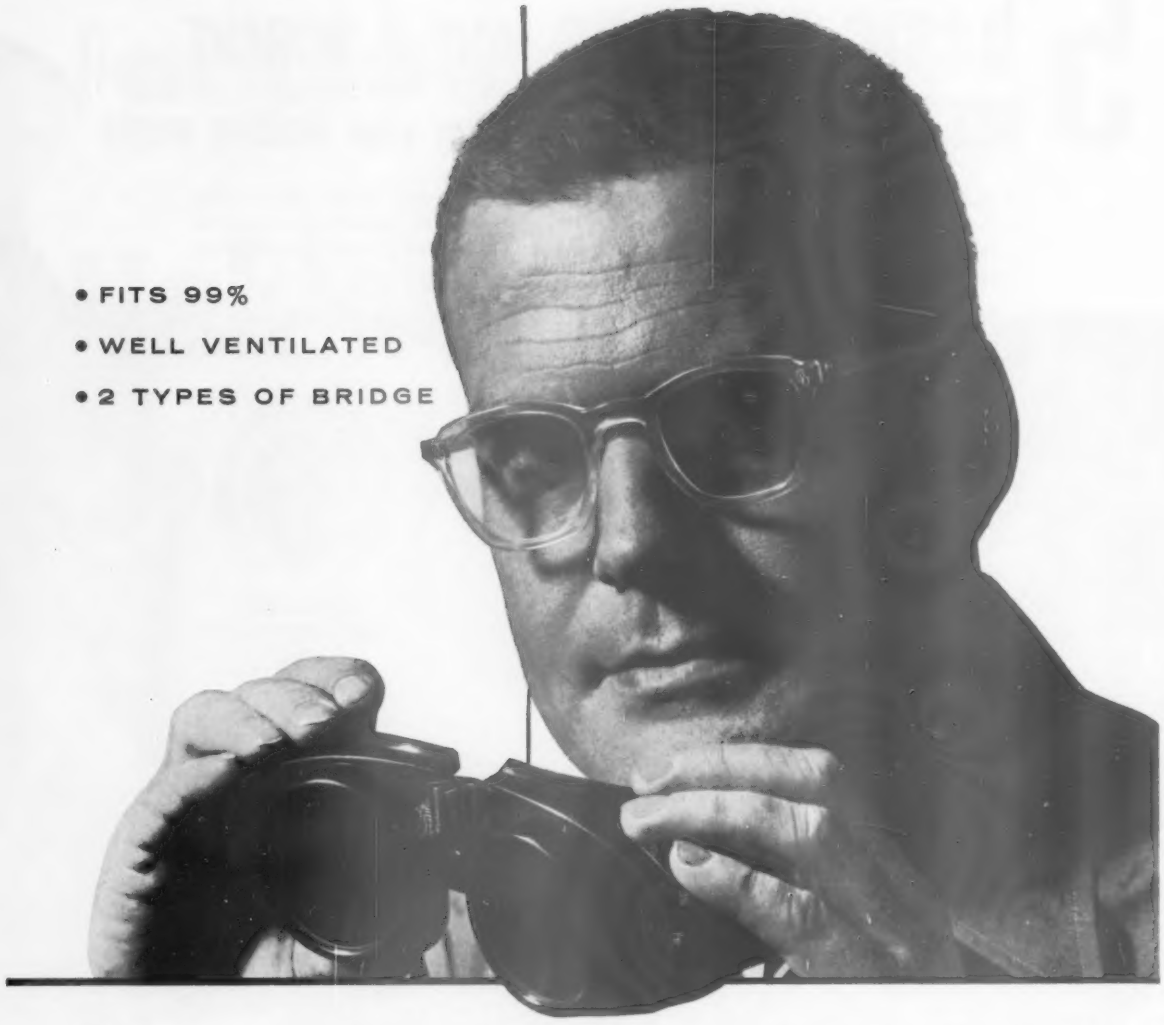
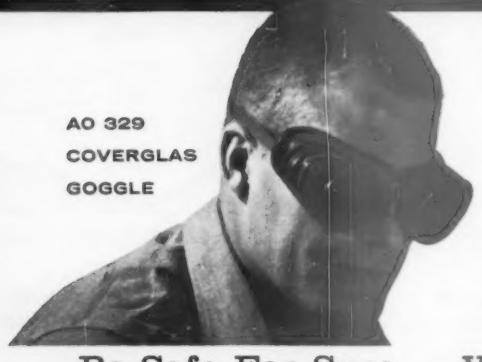
☐ I'd like information on _____ type electrodes for welding _____



This is the New AO Coverglas Goggle that Fits Practically Every Welder

BE SURE TO SEE IT!

American Optical
COMPANY
SAFETY PRODUCTS DIVISION
SOUTHBRIDGE, MASSACHUSETTS
Safety Service Centers in Principal Cities



QUICK FACTS

- Accommodates every type of personal glasses.
- 50mm. round lenses (Filterweld Nos. 3, 4, 5 and 6 shades standard).
- Adjustable leather bridge. Also available with rigid bar bridge as 329B.
- Opaque black, cellulose acetate eyecups.
- Companion chippers' model (325) has direct ventilation and clear Super Armorplate lenses.
- Your nearest AO Safety Products Representative can supply you.

Be Safe For Sure . . . With AO SURE-GUARD Goggles

For More Information Circle No. 9 on Reader Service Card.

reader's guide to *for March, 1960*

COVER: Complete X-ray facilities are available to Ellerbee Brothers, Port Arthur, Texas, through the use of a mobile X-ray laboratory and lightweight, compact portable X-ray unit. Welding inspector is operating control box and checking first ring vertical seam on a small diameter tank. Every film is filed for future reference along with a shell plate layout of the exact location of each exposure. (See page 47 for more details.)

A complete report on "The Nondestructive Testing of Welded Fabrications and Structures" starts on page 39.

FEATURES

29 THE EXOTIC METALS: HOW TO WELD THEM

A comprehensive report on the exotic, or active, metals which become brittle or porous and crack if they are not welded in a vacuum or in an inert gas atmosphere.

31 AUTOMATION: THE FUTURE FOR BUTT WELDED STAINLESS FOIL

The mechanism for automated welding of stainless foil exists today. Here's how the latest, completely automated welding equipment will work when manufacturers gear for production.

32 DETERMINING SAFE LOADS ON ECCENTRICALLY LOADED WELD GROUPS

The first in a monthly series of 12 tables. The first eight will cover eccentric loads; the last four will cover allowable loads for welded beam connections.

34 TECHNIQUES FOR CRACK-FREE SURFACING ROLLING MILL ROLLS

To overhaul rolling mills rolls, you must know their chemical and physical properties; and, you must have carefully worked out welding and grinding techniques.

36 WELDED ALUMINUM DUMP TRAILERS CARRY BIGGER PAYLOADS

Lightweight trailers weigh half what a steel dump trailer does. They increase payloads by as much as 3,000 pounds and require virtually no upkeep.

SPECIAL REPORT **NONDESTRUCTIVE TESTING OF WELDED FABRICATIONS**

39 HOW NONDESTRUCTIVE TESTING AIDS IN DESIGNING FOR WELDING

A comprehensive report on how a thorough knowledge of the various nondestructive testing methods can help in the design of low-cost, efficient weldments.

40 WHAT DESIGNERS SHOULD KNOW ABOUT NONDESTRUCTIVE TESTING

Industry leaders explain in detail how the nondestructive testing equipment made by their companies can help designers of weldments do a better job.

41 A GUIDE TO THE NONDESTRUCTIVE TESTING PROCESSES

A discussion of the principal applications, advantages and limitations of the nondestructive testing processes.

47 IDEAS ON WELD TESTING

A round-up of case histories from a variety of industries shows how the various nondestructive testing processes can save time and money.

58 4 THINGS TO KNOW ABOUT INTERPRETING RADIOGRAPHIC FILMS

A discussion of darkroom techniques, proper use of equipment and an explanation of how to interpret radiographic films.

DEPARTMENTS

10 MEN ON THE MOVE

15 NEWS OF THE INDUSTRY

18 WELDING MANAGEMENT

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71 OPPORTUNITIES

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New Bausch & Lomb Line of

WELDERS' CUP-TYPE GOGGLES

Get a greater degree of eye protection, *plus* economy, *plus* worker acceptance. Injection molded from tough thermoplastic in a cool green color, these new, improved goggles resist high impact, are super comfortable, good-looking and easy to keep clean. Famous B&L Arc-Ban lenses in shades 3 through 12 provide safe, scientific protection against injurious radiations.

S-94 CUP-TYPE Basic Bausch & Lomb welders' goggle with the new two-piece louver side shield that excludes light, lets in air. Bead chain bridge adjustment.

S-84 COVERALL Contoured to fit comfortably against face and over all sizes of regular prescription eyewear. Soft leather nose pad with slide adjustment.

S-85 COVERALL with BRACE BAR Brace bar holds both cups together, so goggles may be slipped up, adjusted, or removed with one hand. The bridge may be widened or narrowed by straightening or deepening curved section of brace bar with pliers.

S-84P COVERALL WITH FACE PAD Only Bausch & Lomb has this coverall welders' goggle with the comfort-fitting, removable face pad. Made of soft sponge rubber in a neutral flesh color, it snaps into place easily and it can be removed for cleaning or replacement. Pads may be purchased separately.

BAUSCH & LOMB
SINCE 1853

Bausch & Lomb Optical Co.
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Welding Design & Fabrication

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This ad, currently appearing in Welding Distributor, tells you another reason why it's good business to do business with your Airco Distributor. He has the latest and best in Airco welding equipment for you . . . and also, he's a solid, reliable, growing member of your business community. You'll find your Airco Distributor listed in the Yellow Pages under Welding Equipment and Supplies.

1960-65 program for new AIRCO DISTRIBUTOR ORGANIZATION promises top growth

In Airco's program for growth, progress plans for Airco Distributors play a key part. Latest news here is the "1960-65 AIRCO DISTRIBUTOR MARKETING PROGRAM."

If you're already an Airco Distributor you'll be getting all details soon.

Briefly, the program spells out additional opportunities through new policy guidance, new sales training, new product development . . . increased participation in the equipment and gas markets and more potential volume for Airco Distributors.

If you're not handling the Airco quality line a prompt inquiry might prove to be the best move you ever made: several territories are now open.

AIRCO®

AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated
150 East 42nd Street, New York 17, N.Y.

Offices and authorized distributors in most principal cities

On the west coast— Air Reduction Pacific Company
Internationally— Airco Company International
In Cuba— Cuban Air Products Corporation
In Canada— Air Reduction Canada Limited
All divisions or subsidiaries of Air Reduction Company, Inc.

For More Information Circle No. 3 on Reader Service Card.

new Westinghouse iron powder-coated electrodes enable

For superior, faster, easier welding, try the new ZIP-10 electrodes—latest advance from Westinghouse research and development. Key to the ZIP-10's performance: a special iron-powder coating that helps boost welding speed . . . makes welding easier because of more spray-type metal transfer . . . permits instant restrike whether the tip is hot or cold. With ZIP-10 iron powder-coated electrodes, welds are smooth, strong, continuous . . . free from breakdowns, pin holes, puffing craters. Undercuts are reduced. Slag is simple to remove. And the ZIP-10 produces outstanding welds regardless of the position in which they are held.

faster welding, instant restrike, hot or cold

Check your nearest franchised Westinghouse welding distributor about the new ZIP-10, one of a series of iron powder-coated electrodes . . . as well as the other electrodes in the complete Westinghouse line. Write Westinghouse Electric Corporation, Welding Department, 4454 Genesee Street, Buffalo 5, New York, for a pocket-sized electrode selector booklet.

J-10482

watch Westinghouse for new developments in welding

YOU CAN BE SURE... IF IT'S Westinghouse

For More Information Circle No. 70 on Reader Service Card.

Introducing the NEW MODEL 1-A SEVER-ALL Machine... CUTS AT 3 to 6 SECONDS PER SQUARE INCH—ECONOMICALLY

MANY EXTRA FEATURES AT A DELIVERED COST UNDER $500

You get the cut quality and capacity of machines nearly three times as expensive when you use the new Model 1-A SEVER-ALL oscillating dry abrasive cut-off machine. Available from your distributor's stock. Here's why the #1-A SEVER-ALL is ideal for industrial and machine shop operations:

BIG CAPACITY • Up to 2″ square solids, 3½″ O. D. pipe and tubing, 3″ angle iron, and 4″ channels . . . of cold rolled, stainless, and alloyed steel; cast iron; and nonferrous metals. Wheel oscillation, an exclusive feature in this price range, provides this *above-average* capacity.

SPEED • Cuts a 2″ x 2″ hardened steel bar in 16 seconds . . . other shapes and sizes at 3 to 6 seconds per square inch.

QUALITY • Clean, smooth cuts, even on large sections, because wheel oscillation provides cooler cutting.

ECONOMY • In addition to low initial cost, the Model 1-A SEVER-ALL is inexpensive to operate . . . occupies minimum floor space . . . requires little or no set-up time . . . eliminates annealing costs . . . gives more cuts per wheel because of oscillation.

SIMPLICITY • Just two SEVER-ALL cutting wheel specifications will do *all* your SEVER-ALL cutting jobs. A positive, screw-type vise holds all regular shapes, and an adjustable work stop provides speed and accuracy.

ANGLE CUTS • Optional accessory permits cutting angles up to 45° in either direction.

NEW SEVER-ALL AVAILABLE FROM DISTRIBUTORS

Very likely your own distributor already stocks the Model 1-A SEVER-ALL machine and wheels. If not, let us know, and we'll give you the name of your nearest SEVER-ALL distributor. Also, we'll be glad to send you complete details on this new machine. Just ask for **Bulletin DH-106.**

ALLISON-CAMPBELL DIVISION
AMERICAN CHAIN & CABLE

ACCO

925 Connecticut Avenue, Bridgeport 2, Conn.

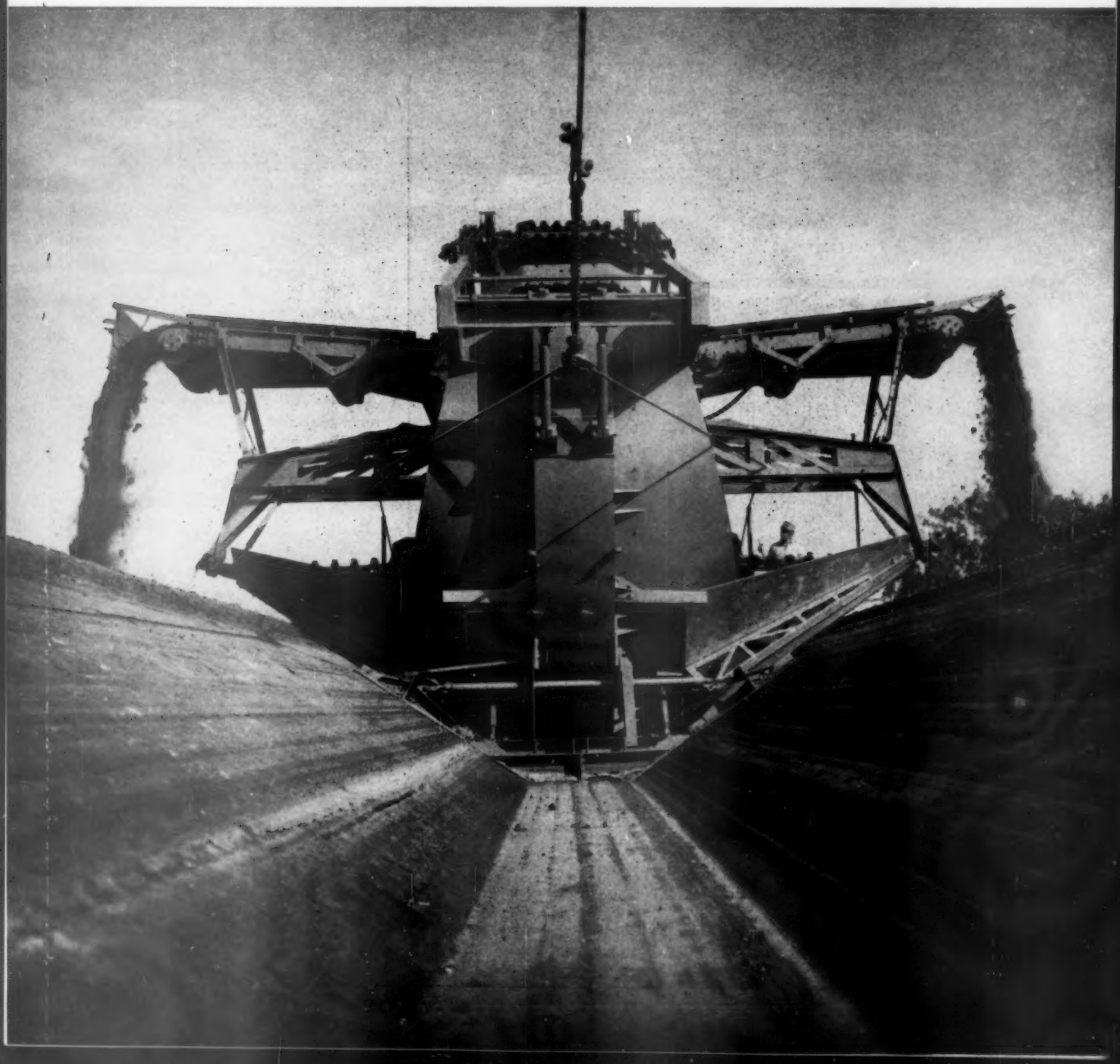
For More Information Circle No. 6 on Reader Service Card.

Circle No. 46 on Reader Service Card. ⟶

World's fastest ditcher welded with M&T Murex ELECTRODES

This monster machine carves out a continuous ditch 6′ deep, 4′ across at the bottom and 22′ across at the top, at the rate of 7′ a minute. Working at its top capacity of 800 cubic yards of earth an hour, the ditcher could keep a large fleet of dump trucks mighty busy. To give its all-welded frame superior rigidity for uniform digging, Gar Wood Industries used Murex electrodes – products of METAL & THERMIT CORPORATION, General Offices: Rahway, New Jersey.

MUREX
PRODUCTS FOR BETTER WELDING



MOBILE GAS STORAGE

WHERE YOU WANT IT FAST WITH

GAS TRANSPORTS

"Mobile" is defined in the dictionary as being "characterized by ease of movement — capable of being readily moved about." This is a perfect explanation of the principle advantage of Taylor-Wharton Gas Transports.

Along with mobility, the transports afford semi-permanent storage of gases in tubes, with capacities up to 100,000 cu. ft. or more depending upon the size and type.

Each modern Taylor-Wharton Gas Transport consists of normalized seamless steel pressure vessels, inspected and tested to I. C. C. 3A-2400 specifications. The vessels are rigidly grouped and mounted on a special trailer chassis with either single or tandem axle. The transport is delivered ready for use, with tubes manifolded to a common outlet in a rear-mounted weatherproof cabinet.

Catalog No. 58 gives complete details on this practical system for flexible gas storage. Write for it today.

More than a Century in Harrisburg 25, Pa.

H HARRISBURG STEEL CO.

Division of HARSCO CORPORATION

CYLINDERS TUBES FLANGES COUPLINGS

For More Information Circle No. 32 on Reader Service Card.

MEN ON THE MOVE

in the welding industry

Fisher

Oberg

PROMOTIONS:

Election of **A. J. Fisher, Jr.,** as executive vice president, Metal & Thermit Corp., New York City, has been announced. Appointed vice president at M&T is **James L. Oberg,** who continues as general manager of Metals and Minerals Division.

New sales manager at Milwaukee Electric Tool Corp. Milwaukee, is **Morrie E. Halvorsen.**

New field engineers for Norton Company, Worcester, Mass., are **Robert V. George** (Detroit) and **Edwin R. Larson** (San Francisco). **Roderick L. Smith** has been named district sales engineer in Indianapolis.

Dexter G. Sherwood has been named assistant manager of marketing and advertising of the Amsco Division of American Brake Shoe Co., Chicago Heights, Ill.

Richard M. Peck is new West Coast District sales manager for Harris Calorific Co., Cleveland.

ANNIVERSARIES:

One of the country's foremost authorities on soldering fluxes is celebrating his 50th anniversary. He is **Frank D. McBride,** president of American Solder & Flux Co., Philadelphia, which was founded in 1910.

continued on page 12

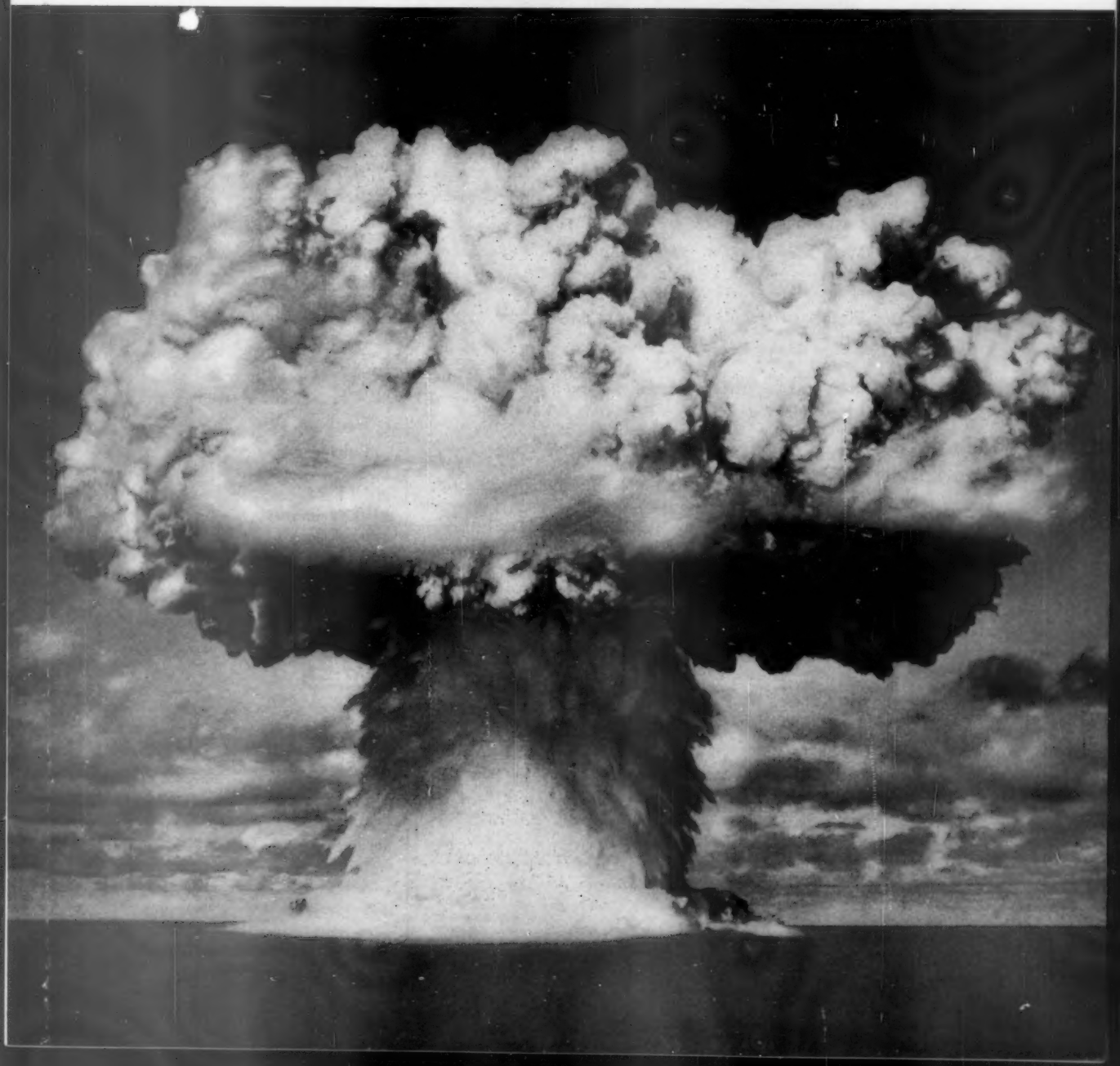
Circle No. 47 on Reader Service Card. ⟶

Complete your shop

World's toughest test withstood by M&T Murex ELECTRODES

Behlen Frameless Metal Buildings have survived what's probably the world's toughest single test—a nuclear explosion. One of the prefabricated buildings was placed only 6,800 feet from blast center and remained erect. A duplicate building 15,000 feet away suffered almost no structural damage. In welding the components used in constructing churches, plants, schools, supermarkets, commercial and farm buildings, Behlen Manufacturing Company relies heavily on Murex electrodes – products of METAL & THERMIT CORPORATION, General Offices: Rahway, New Jersey.

MUREX
PRODUCTS FOR BETTER WELDING



Complete your shop with this modern metallizing installation

WIRE GUN
Sprays any metal that can be drawn into wire form.

POWDER GUN
Sprays hard-facing alloys and ceramics in powder form.

Without metallizing no maintenance or "job" shop can offer the same complete service as the shop that uses industry's low-cost "putting-on" tool.

With modern, low-cost metallizing equipment you can spray carbon steels, stainless, babbitts, brass, bronze, nickel, aluminum, tin, zinc, special hard facing alloys including tungsten carbide.

- **Save up to 90% of replacement costs on machine repair jobs**
- **Do your own hard-facing at high speed, low cost**
- **Apply long-wearing, corrosion-resistant coatings**

A real opportunity for the smaller shop

Thousands of large, well-known companies and shops have been metallizing users for many years, not only in maintenance work but in production applications on original equipment. Now, with modern low-cost metallizing equipment this high-speed "putting-on" tool is within the reach of even the smallest shop.

FREE BULLETIN

Send off the coupon for detailed information — find out how a metallizing installation can pay for itself in a very short time. No obligation, of course.

Metallizing Engineering Co., Inc.
1179 Prospect Ave., Westbury, L. I., New York

Please send me free bulletin on metallizing.

Name _____

Title _____

Company _____

Address _____

City _____ Zone _____ State _____

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1179 Prospect Ave., Westbury, L. I., New York • cable: METCO
to Great Britain: Telephone: EDGEWOOD 4-1300
METALLIZING EQUIPMENT COMPANY, LTD.—Chobham near Woking, England

For More Information Circle No. 50 on Reader Service Card.

MEN ON THE MOVE

continued from page 10

Leach

Steffenauer

APPOINTMENTS:

Austin F. Leach has been appointed Manager of Stud Welding Sales at OMARK Industries, Portland, Oregon. Mr. Leach had served in various engineering and sales positions with GE's Welding Dept.

Louis G. Steffenauer has been appointed sales manager at K-G Equipment Co., Inc., Division of Air Products, Inc., Allentown, Pa. Mr. Steffenauer was formerly assistant district manager for Air Products, serving the New Jersey, New York and Eastern marketing areas.

Charles Beane has joined the sales staff of Fibre-Metal Products Co., Chester, Pa. He will call on distributors in the New England and New York State territories.

Louis J. J. Smith is the new sales manager of Robinson Welding Supply Co., Detroit. He returns to the welding industry after several years absence, according to **J. M. Robinson.** At the same time, Robinson anannounced that **R. K. (Dick) Reynolds** was leaving the company and will enter the insurance business.

DEATHS:

Dead at 81 is **Albert F. Siebert,** president and founder of Milwaukee Electric Tool Corp., Milwaukee.

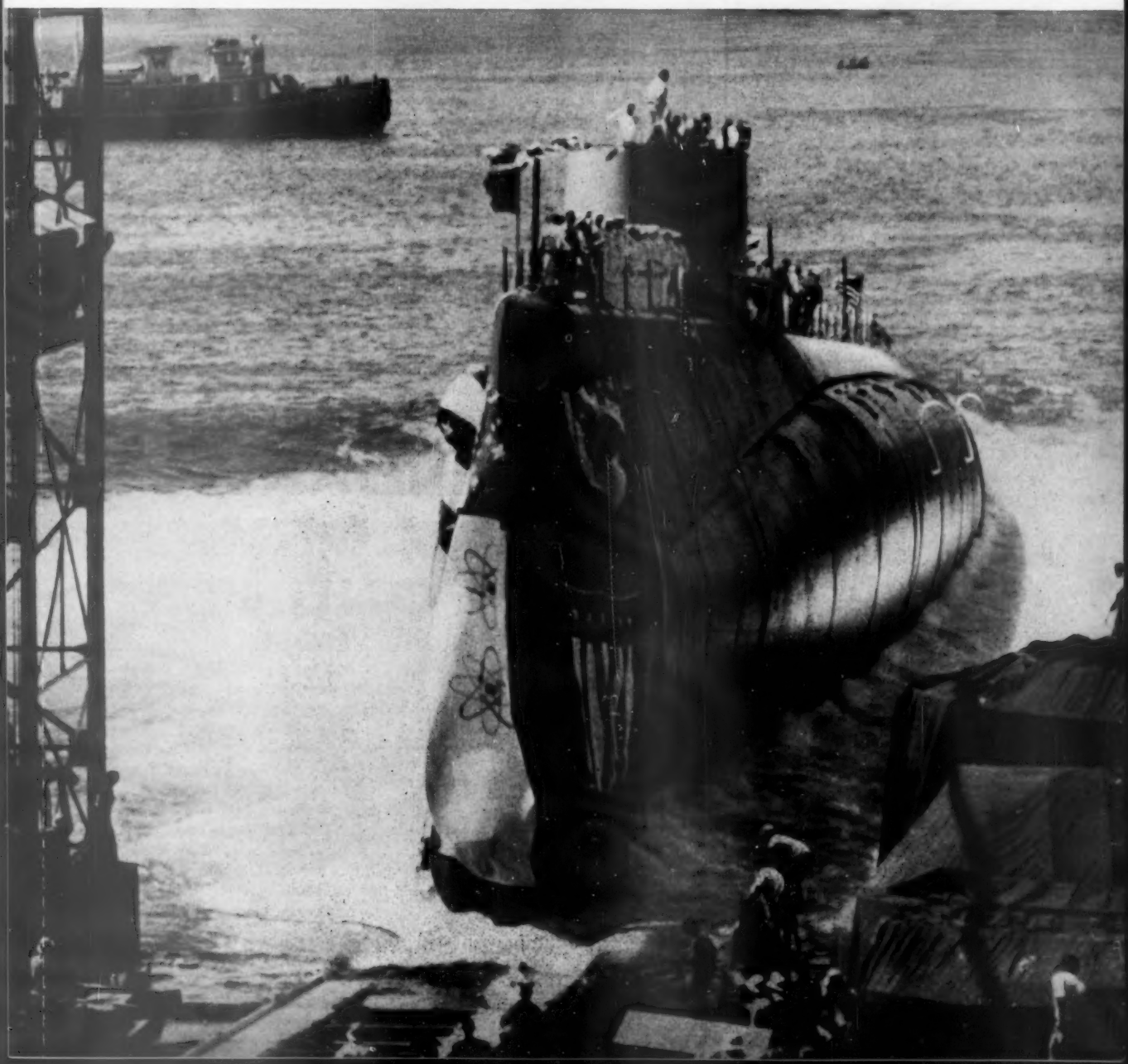
James I. Banash, consulting engineer, died early this year. He was an authority on safety measures concerning compressed gases and was widely known as an author, lecturer and specialist in the prevention of fires and accidents.

Circle No. 48 on Reader Service Card. ⟶

World's biggest submarine welded with M&T Murex ELECTRODES

The U.S.S. Triton—launched in May 1958, commissioned in November 1959—can travel completely submerged for more than two months with a crew of 148. This atom-powered giant, built by the Electric Boat Division of General Dynamics Corp., is three times heavier and 40% longer than conventional World War II subs. Construction consumed some 200,000 pounds of Murex electrodes – products of METAL & THERMIT CORPORATION, General Offices: Rahway, N. J.

MUREX
PRODUCTS FOR BETTER WELDING

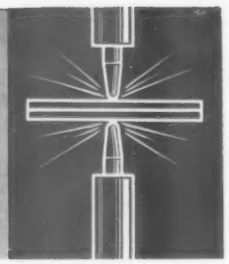


P R MALLORY & CO Inc

MALLORY MEMOS

NEWS AND TIPS ON RESISTANCE WELDING

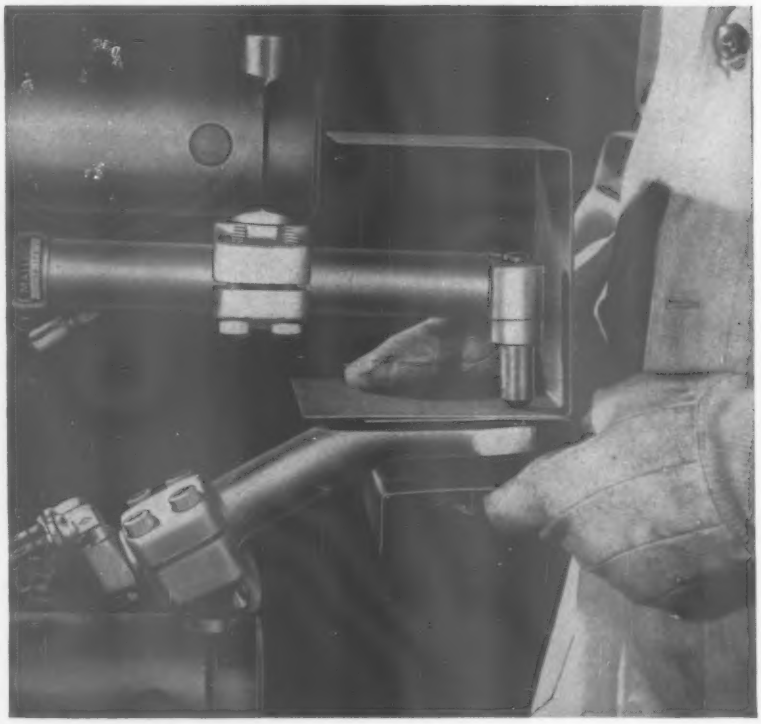
Mallory Metallurgical Company, Indianapolis 6, Indiana



WELDING HINTS

SPECIALLY PRICED HOLDER KITS simplify set-up for short-run welding. Ideal for small shops, maintenance shops, engineering model shops . . . and for big shops handling occasional short runs. Gives you a selection of holder barrels and adapters that lets you make a variety of set-ups. 11 different kits available. Buying complete kit saves you *nearly half* the cost of parts if purchased separately . . . prevents delays, assures the holder you want when you want it.

COMPLETE, HANDY LISTING OF ALL MALLORY ELECTRODES in this latest 32-page catalog, helps you choose the electrodes you need to fit any welding job. Full of helpful recommendations on electrode alloys to use with various metals, how to dress electrode tips, welding schedules for seam and spot welding of stainless and low carbon steels, design data and welding requirements for projection welds. Get a copy from your distributor.



"Tight Squeeze" welds are easy...with

STANDARD MALLORY COMPONENTS

The resistance welding operation shown here may look special. But . . . there's no need for special holders and electrodes; you can do the job with standard, economical Mallory components. On the upper arm is a standard Mallory 100 Series straight holder with 90° adapter head, and a straight truncated cone tip electrode. The lower assembly is a 950 Series paddle type holder, with a socket type flat faced electrode.

Before you go to the extra time and trouble to order special welding components for a job that looks tricky, check what you can do with standard Mallory items. Immediately available at economical price are over 200 different electrodes...straight, single bend, double bend, swivel, offset, irregular shapes . . . and a line of holders including straight, universal, low inertia, heavy duty and paddle types. You can put these together in thousands of combinations to fit just about any job in your shop. And when you use Mallory supplies, you're sure of service. Our alloys and designs are the result of over 30 years of pioneering in resistance welding.

MALLORY RESISTANCE WELDING PRODUCTS ARE AVAILABLE FROM AUTHORIZED DISTRIBUTORS LOCATED IN ALL PRINCIPAL CITIES

For More Information Circle No. 45 on Reader Service Card.

PAUL GALTON (left) and **H. K. SMITH** discuss the fact that . . .

Ransome Will Manufacture In Texas

NEW YORK CITY: Ransome Company will build a plant in Houston, Texas, for the manufacture of automatic welding positioning equipment and fixtures. The announcement was made here at a press conference by Paul Galton, Ransome general manager, and H. K. Smith, president of Big Three Welding Equipment Co., Houston, which will operate Ransome Company as a division.

Rexarc, Incorporated Is Sight Feed's New Name

WEST ALEXANDRIA, OHIO. The Sight Feed Generator Co. has changed its name to Rexarc, Incorporated. In announcing the change, Carl F. Smith, president, said no changes would be made in personnel, policies or products. He said the change was made to identify his company more closely with the broad range of welding products it now manufactures. These include automatic submerged arc welders and positioners and hardfacing alloys that had been marketed under the Rexarc trade name and the acetylene generators which the company manufactured when it first started operations 35 years ago.

AWS Welding Show Expects 25,000

LOS ANGELES, CALIF.: Over 25,000 engineers, production men, research, development and top management personnel will converge on this city on April 25-29 to participate in the American Welding Society's 41st annual meeting and Welding Show. The technical meetings will be held in the Biltmore Hotel and the Show at the Great Western Exhibit Center.

Nearly 150 national organizations are expected to exhibit; over 100 have already reserved space.

EDITOR'S NOTE: *See the April Welding Show issue of Welding Design & Fabrication for complete coverage of the AWS meeting and a list of exhibitors at the Welding Show.*

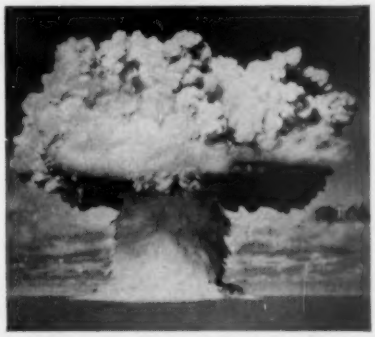
A. O. Smith Expands

ELKHORN, WISCONSIN: A. O. Smith Corp. has increased manufacturing floor space at its Welding Products Division plant there by more than 25 percent, according to G. E. Kemper, division manager. The recent plant addition consists of an assembly area that adjoins the former plant structure.

more news on page 70

AN ANIMATED SIGN displays the name and products of Harris Calorific Co. to passing Clevelanders. The 45-foot structural steel sign with both neon and incandescent flashing lights is on the roof of the company's plant which is located in a park-like area overlooking Cleveland's Memorial Shoreway and Lake Erie. An estimated 2,500 cars pass the building and sign each hour on the Shoreway.

Fastest Ditcher



Toughest Test

Biggest Sub

The stress of moving mountains of raw earth . . . the incessant pressure of the briny depths . . . the devastating blast of man's most destructive weapon . . . welds with Murex electrodes withstood them all.

There's a good reason why Murex electrodes always seem to be chosen for the tough jobs. This is one of the world's broadest . . . and most carefully manufactured . . . lines of electrodes. Over 1000 types and sizes . . . made by men who know their business. Write for literature.

M&T **welding products**

METAL & THERMIT CORPORATION
General Offices: Rahway, New Jersey

Circle No. 49 on Reader Service Card.

This cracked iron housing begged for retirement

But it was hard for the company to comply when they found a new pump housing would cost $1800, would take 90 days for delivery, and would lay off 40 men during the shutdown.

So they sent it over to Lawton-Schrader, a welding company in Richmond, Virginia to see if it could be repaired. Their weldors said it could be *permanently* repaired with Ni-Rod* "55" Electrodes. And they did it. All it took was 8 hours, 5 passes, and 23 pounds of Ni-Rod "55" Electrodes which also eliminated the need for preheat and postheat.

Back on the job in 1½ days, this pump housing is expected to last till the pump wears out. And the total cost came to $384, a saving of over $1400.

Good to keep in mind and on hand

The example above brings out two good points. One...it's a good idea to keep Ni-Rod "55" in mind for emergency repair of cast iron parts. Two...it's even a better idea to keep a supply on hand to meet these emergencies when they come up.

Ni-Rod "55" makes permanent repairs possible with a minimum of time lost, and with a minimum of effort and money spent. It offers you a practical way to salvage defective castings and to join cast irons to other metals. It's ideal for building up worn or undersized areas. Machinable Ni-Rod "55" deposits give service as good or better than the original metal. And in 9 out of 10 cases, no preheat or postheat is needed.

Booklet gives complete data

"Repair Cast Iron Parts Quickly and Easily" tells the Ni-Rod "55" story in detail. It's yours for the asking. Write:

*Inco trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

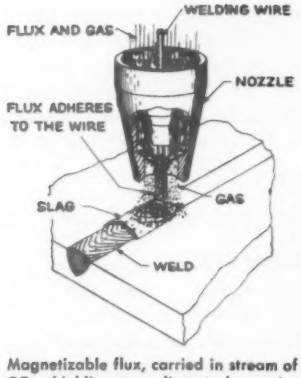
INCO WELDING PRODUCTS
TRADE MARK
electrodes • wires • fluxes

For More Information Circle No. 38 on Reader Service Card.

NEW CO_2 MAGNETIC FLUX MACHINES

Oil storage tank UNIONARC welded by Ellerbee Brothers, Port Arthur, Texas

...CUT WELDING TIME 62%



Magnetizable flux, carried in stream of CO_2 shielding gas, clings to bare wire fed automatically into weld zone. Flux refines weld metal, prevents contamination, controls contour, lowers cooling rate, and stabilizes arc.

LINDE's *new, portable* CO_2 magnetic flux UNIONARC UAM-2 welding machines, used to field-erect three oil storage tanks, paid for themselves in time savings alone . . . depositing as much metal in one pass as coated electrodes did in three. Over 10,000 ft. of welds without a single defect . . . welding man-hours cut from 1850 to 700 . . . cleaning costs cut two-thirds.

UNIONARC welding, fastest manually-operated method for welding steel, uses low-cost carbon dioxide, magnetic flux, and a continuously-fed wire electrode . . . all automatically controlled. No stopping to change electrodes. No plate preparation necessary. X-ray quality welds in all positions. Complete penetration despite normal rust. Negligible spatter. Requires less operator skill than coated electrodes. Deposits 9 to 18 lbs. of weld metal per arc hour (3/32-in. wire, 300 to 500 amperes).

Write for booklet (F-1376) on other cost-saving UNIONARC welding applications: Dept. WDF-03, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Terms "Linde," "Union Carbide," and "Unionarc" are trade marks of Union Carbide Corporation.

Linde UNION CARBIDE

For More Information Circle No. 43 on Reader Service Card.

WELDING MANAGEMENT

watches these developments

A STANDARDIZATION PROJECT for shop fabricated metallic storage and processing tanks used by the chemical industry has been recommended by a general conference of 25 representatives of the chemical industry, tank manufacturers, corrosion engineers and metal suppliers. Among features to be standardized are capacities, dimensions and physical properties, including corrosion resistance. Purpose of the standards project is the reduction of manufacturing costs, delivery time, installation costs and stockkeeping of parts. The conference also recommended that tanks be designed to permit shipment by common carriers.

OHIO LOSES RANK to Pennsylvania. After having held second position in manufacturing activity for five years, Ohio lost that position to Pennsylvania which won out by a margin of $122 million in value-added-by-manufacture during 1957. New York retained first place. Prior to 1952 Pennsylvania held second place.

Ohio's percentage gain in manufacturing during the period from 1956 to 1957 was only 0.46, while Pennsylvania gained 4.5 percent; the total U.S. gain was 3.5 percent.

Will Ohio win back second place? The soon-to-be-released 1958 Census of Manufactures will have the answer.

LOW-ALLOY HIGH-TENSILE STEELS and their effect on welded fabrications and structures will be the subject of a six-part editorial feature in our April Welding Show issue. Featured will be articles on the designing, welding and fabricating of these steels. Also included will be comparison charts of low-alloy high-tensile steels and electrodes and a case history roundup.

ANOTHER ALL-WELDED AUTOMOBILE makes its debut the middle of this month. Unitized body construction eliminates the conventional frame on Ford's new Comet, gives more resistance to bending and twisting forces and saves weight. The Comet has a longer wheelbase than other smaller cars, yet it is two to three feet shorter than standard size cars. It goes on sale at Mercury-Comet dealers on March 17.

STEAM WELDING is a new idea in the Soviet Union. It's used in shielded arc welding. Water vapor is said to become a protective medium that prevents porosity and improves over-all weld quality. Both semi-automatic vapor-welders have been designed; prototype units have been built. Standard welding wires are used.

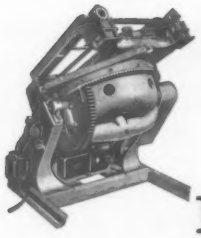
STEELMAKING FURNACES in the United States produced 93,436,813 net tons of ingot and steel for castings during 1959, according to a preliminary report from the American Iron and Steel Institute. The total was the seventh highest in the history of the industry and was over 8 million tons above the 85,254,885 tons made during 1958. According to AISI's index of steelmaking, the 1959 production was 111.6 in terms of the basic index of average production during the period 1947-49. This compared with 101.8 in 1958.

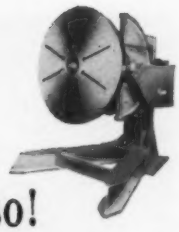
A simultaneous announcement indicates that iron and steel companies will spend a near-record $1.6 billion for new equipment and construction in 1960.

YEAR-END FIGURES compiled by the Resistance Welder Manufacturers Association show that members enjoyed a 40 percent new business increase in 1959 over 1958. Orders for December were 26 percent ahead of November. Shipments for 1959 were 29 percent ahead of 1959, while December shipments exceeded November figures by 47 percent. Backlogs at the end of December were more than $10 million—the high for the year.

TO TEACH THE PRINCIPLES of silver alloy brazing to engineers and supervisors, particularly those in charge of production training, Handy & Harman has developed a packaged, self-study training course. It comes complete in a single package containing three comprehensive textbooks and all parts, materials and supplies needed to perform the lesson exercises. Cost is $25.00. Contact Handy & Harman at 82 Fulton St., New York 38, New York.

FIRST SHIPMENT OF ALUMINUM members for a structure to serve the world's highest voltage electric power line has been made by Aluminum Company of America. When assembled, they will form the world's largest aluminum substation. The aluminum components will comprise the North Substation of the pioneering "Project EHV" (Extra High Voltage) power line now being constructed in western Massachusetts.





Ransome imagin-eering will make it so!

Ransome Company

SCOTCH PLAINS, New Jersey

RANSOME . . . THE PIONEER IN POSITIONING FOR WELDING

Imagination in concert with engineering are the guideposts of Ransome's design for the future. With 110 years' tradition of craftsmanship behind the company, there are unlimited horizons ahead. In the designer's fertile mind, on the drafting table, in the plant . . . new Ransome products are being developed to keep Ransome a step ahead in welding. *You can expect the new, the different, the better from Ransome;* positioning equipment featuring closer tolerances to turn out more precise and accurate weldments, handle heavier loads and provide more extensive automatic controls. We'd like to apply the new Ransome concept of imagination and engineering to your next positioner or welding automation requirement—please write to see how Ransome can go to work for you.

VISIT OUR BOOTH 400 AT THE WELDING SHOW APRIL 26, 27, 28—LOS ANGELES, CALIFORNIA

For More Information Circle No. 57 on Reader Service Card.

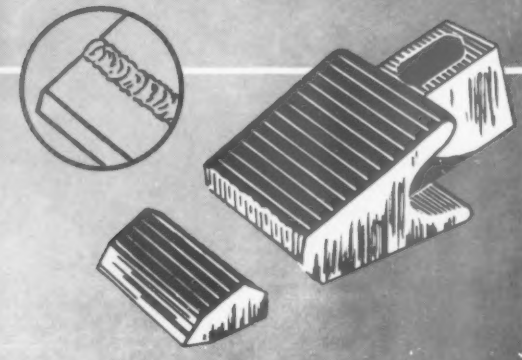
not 1... not 2... but...
THREE GOOD TIPS
for repointing shovel teeth FAST

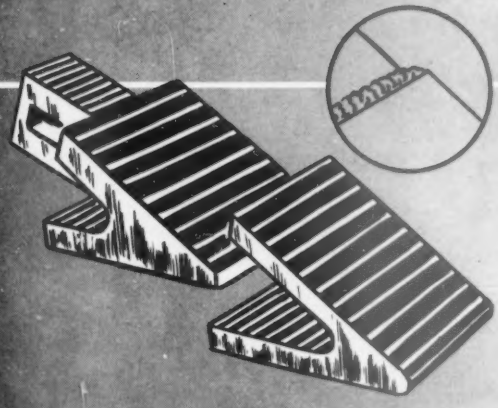
MANGANAL®

11% - 13½% MANGANESE-NICKEL STEEL

WEDGE BARS

AVAILABLE IN 23 SIZES.
36" TO 42" RANDOM LENGTHS.
OR 18' TO 20' MILL LENGTHS.





MANGANAL®

11%-14% MANGANESE STEEL

WING-DING®

INDIVIDUAL SLIPOVERS

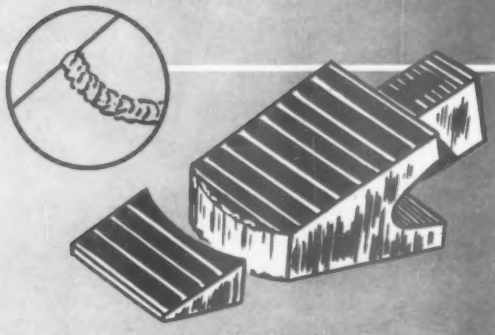
AVAILABLE IN 9 SIZES.
ELIMINATE BUILD-UP TIME.

SS CRESCENTS

WEAR-RESISTANT ALLOY STEEL

TOOTH RE-POINTERS

AVAILABLE IN 4 SIZES.
EASILY APPLIED BY ANY WELDOR.



NEAREST DISTRIBUTOR UPON REQUEST
WRITE FOR COMPLETE DETAILS

NATIONAL WELDING SUPPLY ASSOCIATION MEMBER

STULZ-SICKLES CO.
929 Julia Street • Elizabeth, New Jersey

For More Information Circle No. 64 on Reader Service Card.

Circle No. 30 on Reader Service Card. ——→

IF IT'S STEEL...

THERE'S A P&H ELECTRODE TAILORED TO WELD IT!

P&H offers you a type and size for every job.

Whatever the steel, Harnischfeger can provide the right electrode to weld it.

This broad selection enables you to match the chemical analysis, strength, and heat-treating properties of any steel. Precise quality control assures superior welding characteristics for all jobs. The results: faster, smoother deposits — minimum spatter — and strong, ductile welds.

For example, you can really pour it on with P&H ultra-fast electrodes. Low-hydrogen types let you weld difficult steels with little or no pre-heat — and without cracks or pores. Still others provide both speed and quality for "taming" problem steels.

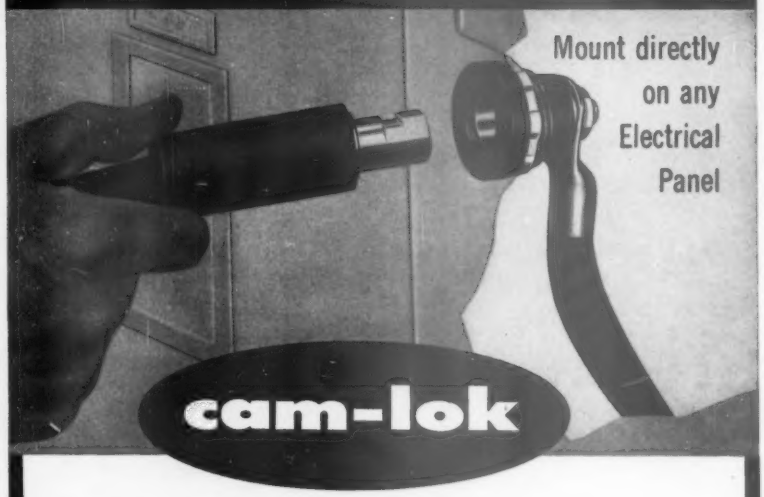
In addition, the P&H line includes a full range of stainless steel, mild steel, alloy, and hard-surfacing electrodes. Investigate P&H job-mated electrodes today. Send for Bulletin R-29 covering the entire line.

313

P&H **HARNISCHFEGER**
WELDERS • ELECTRODES • POSITIONERS
MILWAUKEE 46, WISCONSIN

Export Division:
4329 W. National Ave., Milwaukee, Wis.

New Hi-Impact Plastic Insulated
Panel Receptacles and Mating Plugs



Now, you can make fast, positive power connections to any metal panel or housing without special insulating materials. Simply punch out a hole and insert a Cam-Lok self-insulated Receptacle! Uses standard electrical lock-nuts, affords "dead-front" protection. Push in and twist Cam-Lok mating Plug and you've made a locked connection, which can be released quickly.

New Cam-Lok Receptacles eliminate costs of special insulating panels and reduce assembly time. Patented, high-pressure contact assures minimum resistance and heating.

Cam-Lok has a complete line of Receptacles and Plugs in many sizes and designs. Standard and special purpose Power Distribution Connections are available. Write today for new Bulletin No. 301.

"Dead Front" design for fast
direct mounting on . . .

• ELECTRICAL DISTRIBUTION PANELS • SWITCHGEAR
• BUS DUCT • JUNCTION BOXES
• WIREWAY or any electrical cubicle

A Complete Line of Welding Accessories and Special Power Distribution Connections

cam-lok DIVISION

EMPIRE PRODUCTS, INC.
P.O. BOX U-98
CINCINNATI 36, OHIO

For More Information Circle No. 17 on Reader Service Card.

BUGDUSTER AUGER used in coal cutting machines has 32 weeks of service life instead of five as . . .

Tungsten carbide surfacing boosts auger life 6 times

HUNKERS, PA.: Tungsten carbide hard facing has increased by six times the service life of bugduster augers on coal cutting machines in the Delmont Fuel Company's No. 10 Mine.

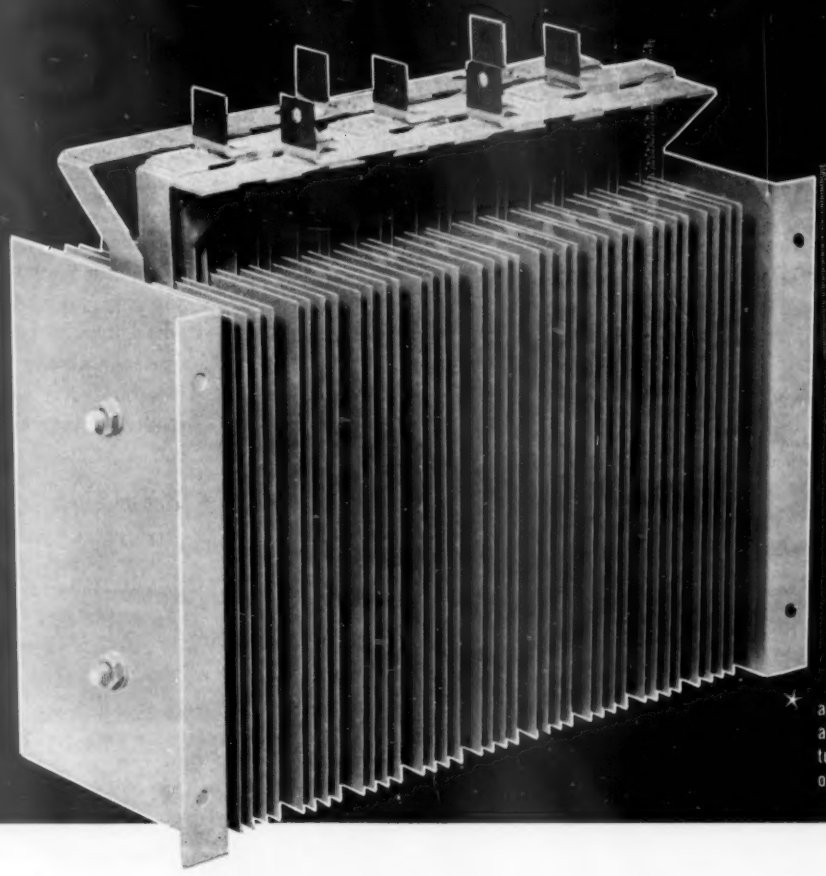
The area of severest wear on these augers, which eject fine coal cuttings from the side of the machine, is on the discharge end. Augers are commonly turned end-for-end after one end is worn excessively. The best auger material for this abrasive wear had to be reversed after not more than five weeks of service.

This period was extended to 32 weeks after the end of an 8-inch diameter auger was hard faced with tungsten carbide material developed by Kennametal, Inc., Latrobe, Pa. The hard facing material is known as KT-80 Tube Kenface and has an approximate ratio of 60 percent carbide to 40 percent steel in the tubes.

Application is made using standard procedures with an oxy-acetylene torch. The deposit was put on the edge of the helical blade and a pressure face 180° from the discharge end. The cleaned surface on the end of the auger was heated to a sweat

continued on page 59

CYNOSURE ★



★ anything to which attention is strongly turned; a center of attraction.

INDEED the center of attraction — The best and longest lasting rectifier ever placed in a welding machine

The mighty heart of the entire line of **MILLER GOLD STAR WELDERS** is the rectifier stack illustrated above. A **MILLER** designed, **MILLER** built and **MILLER** guaranteed component — one that has proven itself by establishing unprecedented performance records in the only service in which you are interested — arc welding.

We, too, are interested in no other service. For that reason we have built, tested and retested welders utilizing every available rectifier — and every time the answer is still the stack illustrated above.

And the "secret" why this rectifier stack is superior to other similar devices? **SIMPLE** — **MILLER** research directed only to a better and better rectifier **FOR WELDING ONLY** — **MILLER** quality production control directed toward a uniformly high standard product — **MILLER** production techniques involving extensive automation and electronic process regulation — and **MILLER** "know how" gained as the largest producer of rectifier type welders.

For a more detailed treatment of this subject, you are invited to ask for a free copy of "A New Performance Record in Rectifiers," written by our director of research, G. K. Willecke.

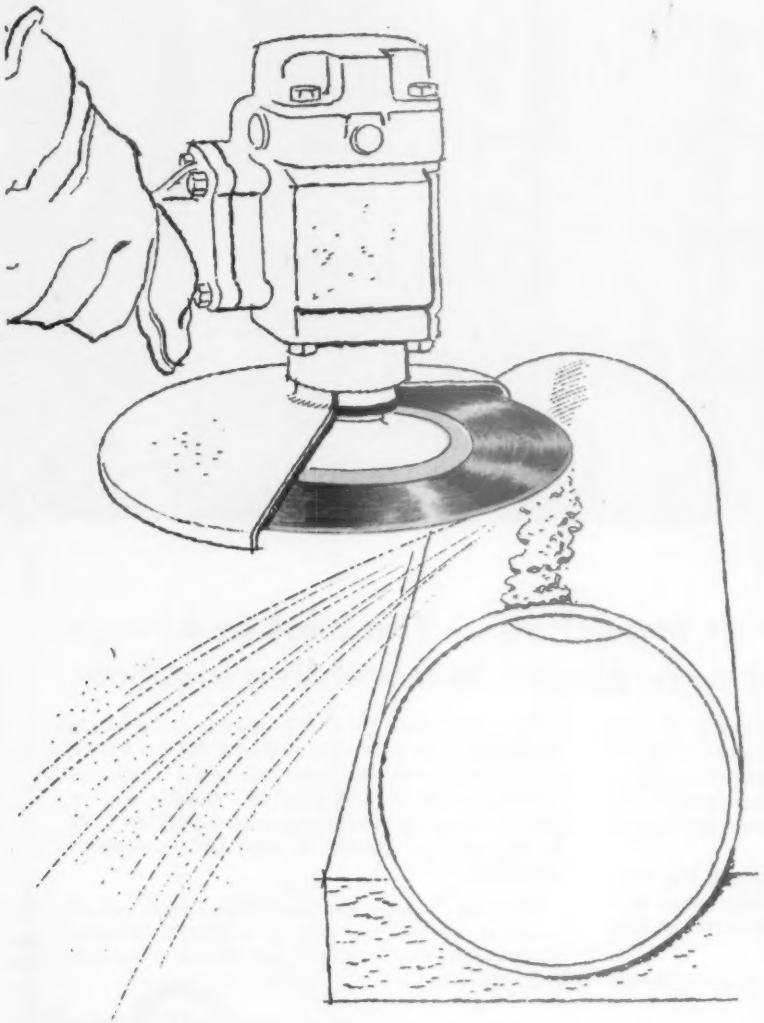
miller WELDERS

miller Electric Manufacturing Company, Inc. — APPLETON, WISCONSIN

EXPORT OFFICE: 250 West 57th St., New York 19, N.Y. • Distributed in Canada by Canadian Liquid Air Co., Ltd., Montreal

For More Information Circle No. 52 on Reader Service Card.

Best news in years about Resinoid Wheels!



Norton Reinforced Resinoid Wheels — rigid and semi-flexible — have long been an unbeatable team for handling an almost endless list of weld grinding jobs.

Today, these weld grinding favorites are produced in the new Norton Worcester Plant No. 8 — five acres of the very latest facilities for grinding wheel manufacture — where quality control, always a key factor at Norton, is now as thorough as ultra-modern equipment and development can make it.

- *Norton BD and BDA rigid wheels, raised hub type, glass-nylon reinforced, are ideal for grinding medium to heavy welds, including stainless steel — and for smoothing flame-cut edges, notching, slotting and cutting-off.*
- *Norton BFR semi-flexible wheels, raised hub type, nylon reinforced, are fast and free cutting in lighter weld grinding, removing scale, blending contours, scarfing and beveling before welding.*

For further facts on the latest, most outstanding progress in weld grinding wheels — both the reinforced types and straight, cups and cones — see your Norton Distributor. Or write to NORTON COMPANY, General Offices, Worcester 6, Massachusetts. Plants and distributors around the world.

NORTON
ABRASIVES

W-1971

75 years of... Making better products ... to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **BEHR-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

For More Information Circle No. 54 on Reader Service Card.

VICTOR

for hardfacing **NI-MN RODS** *for build-up* *for attachment*

Victor Ni-Manganese for Build-up is 4½% nickel, 13% manganese alloy, specifically developed for rebuilding manganese steel parts such as bucket teeth and lips; rail frogs and switches; crusher, dredge, pulverizer components. May be used as finish build-up or underbase; forms sound, slag-free welds; high deposition rate and good weldability. Deposits are austenitic with full Hadfield steel properties; nonmagnetic, tough and ductile; stands roughest abuse. Made in 5/32″, 3/16″ and 1/4″ diameters; bare, for manual application by DC, reverse polarity.

Victor Ni-Manganese for Attachment welds crack-free, is specially recommended for difficult joining applications on manganese or carbon steel castings, such as: Dipper teeth and lips; track and drive sprockets; dragline pins and links; rail crossovers, switches and frogs; rolling mill parts; crusher screens, hammers, rolls and mantles; dredge parts. Deposited metal is extremely tough, wears well, has high impact strength. It's a wonderful, low-cost substitute for "stainless" where joining rather than corrosion resistance is chief factor. Made in 1/8″, 5/32″, 3/16″ and 1/4″ diameters for manual application by AC or DC, reverse polarity.

For all your hardfacing or welding needs, call your Victor dealer. Order Victor Ni-Mn rods today.

Profitable dealerships open; inquire now!

VICTOR EQUIPMENT COMPANY *Alloy Rod & Metal Division* H-65

13808 E. Imperial Highway, Norwalk, California . . . . Wakita, Oklahoma

For More Information Circle No. 68 on Reader Service Card.

For the Welding Industry...

EUTECTIC'S NEW NATION-WIDE TRAINING

In celebrating its 20th Anniversary of Service to Industry, EUTECTIC TAKES THE LEAD AGAIN with the establishment of complete weld training facilities in each of its 16 Service and Training Centers from coast-to-coast in the U.S.A. and Canada.

EUTECTIC has always been a leader in offering the finest training to weldors through the Eutectic Welding Institute. Under this ambitious new program, additional thousands of men in industry will have the opportunity to learn the latest metal joining techniques with the Low Heat Input process.

The courses will show how industry after industry is saving money with more efficient maintenance and repair programs using famous EUTECTIC "Low Temperature Welding Alloys"®. They will show how leakproof, strong joints can be obtained at temperatures hundreds of degrees below the melting point of the parent metal... how difficult metal joining problems such as joining extra thin or dissimilar metals can be solved... how metals from Aluminum to Zinc can be welded and repaired with greater ease and speed than ever before.

Courses will consist of intensive one day sessions and

CELEBRATING OUR 20th ANNIVERSARY OF SERVICE TO INDUSTRY

PROGRAM IN 16 MAJOR CITIES

week long Conference Courses. Each group will be limited to fifteen people to assure that everyone gets the fullest opportunity to profit from the latest advances in welding of heavy castings, tool and die repair, joining different metals and materials, general maintenance and repair problems and their job-proven solutions.

In preparing this, America's largest Weldor Training Program, Eutectic demonstration specialists have drawn upon the experiences acquired in the company's fifty years of research and development... upon its twenty-year background as a world-wide organization... upon the job knowledge acquired by its more than 350 specially trained technical representatives in the field. The well known Eutectic Welding Institute in Flushing, will provide guidance and organize these thorough courses.

EUTECTIC WELDING ALLOYS CORPORATION is the originator, patent holder and sole world-wide manufacturer of EUTECTIC "Low Temperature Welding Alloys". These unique products minimize warping, distortion, weld embrittlement, and other damaging effects to metal encountered with common, high heat materials.

® REGISTERED TRADE MARK OF :

EUTECTIC WELDING ALLOYS CORPORATION

40-40 172nd St., FLUSHING 58, NEW YORK

Service and Training Centers in ATLANTA; BOSTON; CHICAGO; COLUMBUS, OHIO; DALLAS; DETROIT; LOS ANGELES; ST. LOUIS; SEATTLE; BERKELEY, CALIF.; HURON, SO. DAKOTA; PHOENIX, ARIZONA.

Warehouses CANADIAN PLANT AND HEADQUARTERS: MONTREAL DARTMOUTH, N. S., TORONTO AND VANCOUVER

COURSES WILL BE HELD IN THE FOLLOWING LOCATIONS:

ATLANTA; BOSTON; CHICAGO;
COLUMBUS, OHIO; DALLAS;
DETROIT; LOS ANGELES; ST. LOUIS;
SEATTLE; BERKELEY, CALIF.;
HURON, SO. DAKOTA; PHOENIX, ARIZONA.

IN CANADA:
EUTECTIC WELDING ALLOYS CO. OF CANADA, LTD.,
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ST. LAURENT, MONTREAL 9, QUEBEC
DARTMOUTH, N. S., TORONTO AND VANCOUVER
AND MORE TO FOLLOW

VISIT OUR BOOTH 118
APRIL 26-27-28 '60
GREAT WESTERN EXHIBIT CENTER
Los Angeles, Calif.
WELDING SHOW
Sponsor:
AMERICAN WELDING SOCIETY, INC.
APRIL-NATIONAL
WELDED PRODUCTS MONTH

National Manager
Eutectic Welding Institute
EUTECTIC WELDING ALLOYS CORPORATION
40-40 172nd Street, Flushing, New York
Dear Sir:
I am interested in:
- ☐ One-day program
- ☐ One week conference course
- ☐ Evening classes
- ☐ Free booklet on EUTECTIC "Low Temperature Welding Alloys" and Fluxes

Name .....
Company .....
Address .....
City ..... State .....

For More Information Circle No. 23 on Reader Service Card.

Whose neck is he sticking out, anyway, when your production man says,

"Sure! We can deliver on time!"

Yours, isn't it?

Doesn't he mean, "We can deliver on time, IF purchasing can get us the materials we need".

That's why you rely on Lincoln for welders and electrodes.

Lincoln has factory branch offices in every important city, staffed by trained engineers who will help you with production and cost reduction problems.

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BERYLLIUM
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HAFNIUM
MOLYBDENUM
RHENIUM
TANTALUM
THORIUM
TUNGSTEN
TITANIUM
URANIUM
VANADIUM
ZIRCONIUM

MARCH, 1960
Welding Design & Fabrication
ESTABLISHED IN 1930 AS INDUSTRY & WELDING

The Exotic Metals: How To Weld Them

by JOHN HUMINIK, Jr., *laboratory manager, Value Engineering Co., Arlington, Va.*

IN BRIEF: The exotic, or active, metals must be welded only in a vacuum or in an inert gas atmosphere. If these metals are welded in air, they become brittle or porous and welds crack.

YOU NEED a vacuum or a carefully controlled atmosphere to weld most of the active metals. Why? Because most of the pure active metals (and some newer alloys) are easily contaminated by gases, such as oxygen, nitrogen or hydrogen.

Take special care when you design and build this special equipment. It can range from large vacuum or controlled atmosphere chambers to simple trailing shields used with ordinary inert-gas torches.

Argon and helium are commonly used shielding gases, but other gases work. For instance, nitrogen is popular in copper welding, carbon dioxide in welding carbon steel. The best gas to use is the cheapest one that does a satisifactory job. Generally, you need a better and purer grade of inert gas for the reactive metals.

GAS SHIELDING METHODS

Let's take the standard inert-gas welding torches. They are equipped with cylindrical ceramic or metal cups. These cups protect the tungsten electrode from oxidation and they protect the molten metal from oxidation or contamination by other gases.

The shielding cup gives adequate protection for small welds in aluminum, magnesium, carbon steel, stainless and copper. However, when you examine the undersides of these welds you see the signs of oxidation. On many jobs, this oxidation doesn't matter. If it can't be tolerated, then you must use an inert-gas backup. There many ways to go about it. (Figures 1 through 3 show typical gas backups.)

When you design a gas backup, remember that the gas pressure drops the further you get from the gas intake. Inadequate pressure can give inadequate shielding and you are likely to get oxidation. Also consider the increase of gas pressure. It often disturbs the molten weld metal and prevents making sound welds.

Another valuable technique is a trailing shield. The shield, a second inert gas torch cup, travels behind the welding torch. This extra cup shields the cooling weld metal from air contamination.

Figure 4 shows a sophisticated trailing shield.

CHAMBER DESIGNS

There many and varied types of inert-gas or vacuum welding chambers. A simple box chamber can be built from wood, plastic or metal (Figure 5). You can use this sort of chamber for welding or for inert-gas or vacuum soldering.

Figure 6 shows a more elaborate production chamber. You can use a vacuum or inert gas atmo-

Gas shielding methods for welding exotic metals . . .

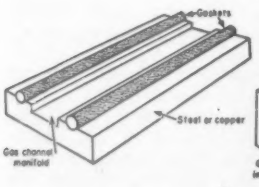


Figure 1. Pressurized gas backup

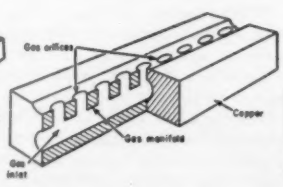


Figure 2. Simple gas flow

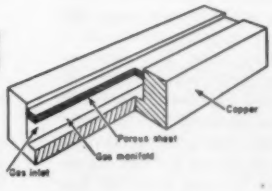


Figure 3. Diffused gas flow

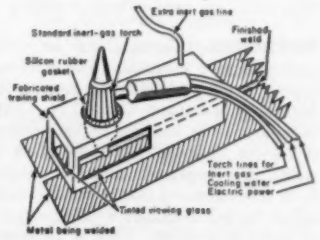


Figure 4. Trailing shield

sphere with it. Use a vacuum purge of about 10^{-4} mm of mercury. If you have a system which will give at least 10^{-6} mm of mercury, you can do without any inert gas except that injected by the welding torch. If you have trouble keeping the metal at welding temperature, a vacuum is better. Heat does not conduct away in a vacuum as easily as it does when you use an inert gas. However, it is impossible to use a glove-type manipulation vacuum chamber. You must then justify the expense of automatic equipment. Often you can't, perhaps because there's little welding or too many shapes that have to be welded.

Vacuum welding has definite advantages over the inert-gas technique for tungsten or tantalum. The high melting point of these metals and the conductivity of inert gases tend to take heat away as fast as the welding torch can put it in.

You need internal lighting, temperature indicators and pressure indicators when you use the chamber in Figure 6. Often you need to water-cool the chamber walls to allow variation of the internal heat when you use inert gas atmospheres. You also need to heat a chamber with small electrical resistance heaters so that you can heat, cool or stabilize the temperature in the chamber. With this chamber you can provide a range of temperatures for preheating and post-heating weldments. To make welding easier and prevent weld cracking you often need preheat temperatures of 300°F or higher.

The design and use of special chambers for welding reactive metals is complicated. You need to be concerned about the operator's safety and efficiency. For example, you need correct height and arm spacing. You need the right window height to keep the operator from getting needlessly tired. Also, if production work is to be welded inside the chambers you need an air lock to keep the atmosphere pure when you put in or take out the work.

You can weld automatically in some of the larger

continued on page 71

Facts about welding the exotic metals . . .

The following welding data on specific metals is based both on experience and research. Note that manual tungsten arc inert-gas welding is the only process considered acceptable and economical at present. The usual power source employed with this method is one which will furnish direct current.

BERYLLIUM: Pure beryllium has been welded by the inert-gas processes but does not have entirely satisfactory weld properties. Two properties of this metal cause trouble when we weld it: rapid oxidation at high temperatures and relatively low ductility.

There is also the problem of high specific heat and heat of fusion. Tendency toward weld cracking indicates that this is a "hot short" metal. The oxide of beryllium which forms during heating, seems to almost prohibit welding. However, the use of inert-gas additives, such as Freon in a one percent volume concentration, overcomes oxidation and reduces porosity. This is not usually done since Freon and other active gases, such as chlorine, are corrosive and harmful to welding chambers and inert-gas torches.

Beryllium can be brazed in an inert atmosphere with aluminum alloys, but the resulting joints are usually porous.

MOLYBDENUM: This metal is weldable in inert-gas chambers. Its high melting point (4752°F) and its sensitivity to the slightest gas contamination make welding difficult. Many cross cracks will be apparent in a finished weld made in a contaminating atmosphere. Less cracking is apparent if the entire weld is not made in one continuous operation.

Experiments using various welding filler metal combinations have been tried. For example, a 10 percent thorium-molybdenum alloy has been investigated with little success. Most important drawback is its very low strength above 1500°F.

At present the commercial arc-cast carbon-deoxidized molybdenum alloy is the most weldable. Low weld ductility below 400°F has been the principal drawback to the use of this metal in applications requiring welding.

TANTALUM: This metal can be welded in a completely inert atmosphere or a vacuum. The welding problems are much the same as for molybdenum except that tantalum melts at a higher temperature (5425°F). Caution must be taken so tantalum is not brought up to welding temperature rapidly. If it is, the tungsten electrode splits and burns-off. Resulting welds are porous and contaminated with pieces of the electrode. It is recommended that a small crucible containing scrap tantalum be melted before welding starts to absorb residual traces of gaseous elements. This is necessary because tantalum has such good gettering properties.

TITANIUM: Even less than 0.5 percent oxygen or nitrogen will embrittle a weld beyond the point of usefulness. Molten titanium is highly reactive with most materials, including all the common refractories. This means weld areas must be free from dust, greases, and contact with ceramic blocks or other foreign materials during welding.

Excessive alloying with structural metals, such as steel or aluminum, forms brittle intermetallic compounds and causes excessive solid solution hardening. This greatly reduces ductility and impact strength.

If inert-gas or vacuum chambers are not available, inert-gas back-up with a trailing shield will give very good results.

TUNGSTEN: Since tungsten melts at 6152°F, it is difficult to bring it up to temperature without melting the tungsten electrode. Pure tungsten is used as the filler metal.

The only answer we have at the present is to preheat the tungsten and then use a 2-percent thoriated tungsten electrode with a diameter five times the thickness of the tungston metal being welded. For example, if you are welding .062-inch tungsten sheet, you need a .312-inch electrode. This rule has its limitations and should be worked out for each job.

Some work has been done using platinum or platinum alloys for filler metal with the inert-gas tungsten arc method of welding. However, this is not truly welding; It is actually brazing since the base metal never reaches its melting point. Vacuum welding of tungsten is favored over inert-gas techniques since the heat loss problem is almost eliminated.

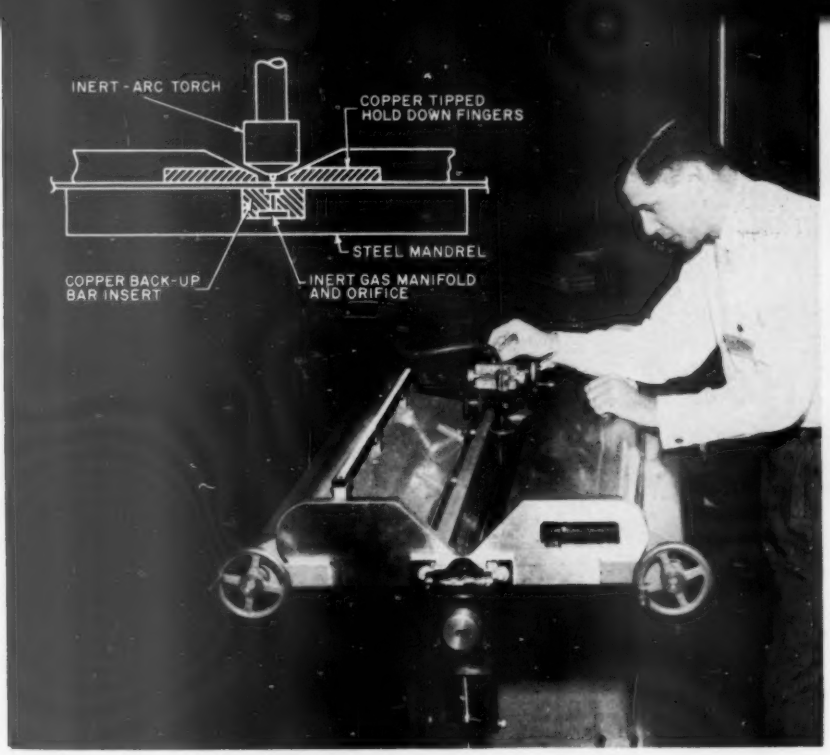
URANIUM: This metal is welded like other non-ferrous metals. A clean surface is needed because thick oxides or other adherent impurities prevent making a good weld. The relatively thin atmospheric oxidations on previously cleaned or freshly machined uranium usually are not harmful to welding operations

If metal surfaces are black (uranium oxide) and wrinkled during welding, an insufficient flow of inert gas is usually the cause. Argon and helium gas mixtures are used as well as either one of two separately.

Direct current (straight polarity) produces highly satisfactory welds. Alternating current generally produces poor arc stability, shallow penetration and low heat input.

Usually a uranium weld is stronger and harder than the parent metal and has a little less elongation ability.

The metal is fairly brittle below about 300°F. Above this transition temperature it becomes quite ductile and can be handled easily in forming operations. Since uranium is highly fluid when molten, positioning is a problem; overhead and vertical welding become difficult, if not, impossible.



KEY TO ACCURACY of the latest machine for butt welding stainless foil is a highly polished guide bar. In 36 inches of travel, the welding head won't veer more than 0.001" from a straight line. Sketch shows the foil-welding set up. Fast-acting copper-tipped hold-down fingers and copper back-up bar shunt heat away from the welding joint.

Automation: The Future For Butt-Welded Stainless Foil

IN BRIEF: The mechanism for automated welding of aircraft and missile skin sheets exists today. Here's how the latest equipment works, and how the completely automated model will work when manufacturers gear for production.

WELDING DATA: AUTOMATIC FUSION BUTT WELDING OF STAINLESS STEEL FOIL

CONSTANTS: Cleaner-acetone; Hold-down pressure-40 psi; Back-up bar-copper; Mandrel-steel; Current-dc; Nozzle-to-work distance-1/4 in.; Weld results-good.

Material	Grade	15-7	15-7	15-7	Am 350
	Thickness, in.	0.010	0.016	0.020	0.015
Hold-down spacing, in.		0.080	0.080	1/8	0.100
Back-up groove	Depth, in.	0.020	0.020	0.020	0.010
	Width, in.	0.080	0.080	0.125	0.100
Gas, cfh	Top	He-30	He-30	He-30	A-5, He-15
	Bottom	A-3	A-3	A-3	A-15
Arc voltage		—	—	—	18
Amperage		18	25	25	30% low
Travel speed, ipm		25	29	20	20
Tungsten diameter, in.		0.040 2%Th	0.0625 2%Th	0.0625 2%Th	0.0625 2%Th
Weld planishing pressure, psi		20	25	25	—

COMPLETELY AUTOMATIC butt welding of foil-thin metal sheets as large as 25 by 20 feet is coming closer every day.

Here's what you might expect with automation: One operator will keep a bank of machines loaded with sheets of foil. Then the electronic tape control or mechanical programming will cause the machines to feed sheets into the welding fixture, position and clamp them, make the weld, then remove and stack the finished parts. The operator will simply make sure all goes well.

Byron R. Russell (president, Airline Welding And Engineering Co.) says the system could be built today. He believes it will have to be built when manufacturers gear up for full production of supersonic planes and space vehicles.

NEED LARGE FOIL SHEETS

Says Russell: "The riveted skin is obsolete. Future aircraft and missiles will have welded skins. The trend is toward metal foil sandwich sections. The need for large foil sheets will force manufacturers into automation.

"The mills can make foils of stainless steels in only 24-inch widths. They must be joined to meet aircraft needs. Today we semiautomatic lap weld or butt weld. These processes are too slow to keep pace with the future."

Russell feels that the mechanism for automated

continued on page 61

Designers Notebook

How To Determine Safe Loads On Eccentrically Loaded Weld Groups

THIS MATERIAL isn't new, but its presentation in tabular form is unusual. Tables of coefficients can be made to cover more variables than graphs.

By interpolating, you can get coefficients from the table with a precision that could be matched only by prohibitively large tables.

This is the first of a monthly series of 12 tables. The first eight will cover eccentric loads on welded groups. The last four will cover allowable loads for welded beam connections. The material is adapted from the *Steel Construction Manual* of the American Institute of Steel Construction. • •

ECCENTRIC LOADS ON WELD GROUPS

COEFFICIENTS

P = Permissible eccentric load in Kips.
l = Length of each weld in inches.
D = Number of sixteenths of an inch in fillet weld size.
C = Coefficients tabulated below.

$$P = CDl$$

Required Minimum $C = \frac{P}{Dl}$

" " $D = \frac{P}{Cl}$

" " $l = \frac{P}{CD}$

SPECIAL CASE

(Load not in plane of weld group.)

Use C-values given in column headed k = 0.

a	k															
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0
0.2	.768	.744	.741	.753	.773	.796	.819	.842	.862	.882	.899	.930	.955	.976	.994	1.01
0.3	.582	.570	.577	.597	.625	.655	.686	.716	.742	.768	.790	.830	.863	.890	.914	.934
0.4	.462	.455	.466	.489	.519	.552	.586	.618	.648	.677	.702	.747	.785	.817	.845	.869
0.5	.380	.377	.389	.412	.441	.475	.509	.542	.573	.603	.630	.678	.719	.754	.785	.811
0.6	.322	.320	.332	.355	.383	.415	.449	.481	.513	.543	.571	.620	.663	.700	.732	.760
0.7	.278	.278	.290	.311	.338	.369	.401	.433	.464	.493	.521	.571	.615	.653	.686	.716
0.8	.244	.246	.257	.276	.302	.331	.362	.392	.423	.452	.479	.529	.572	.611	.645	.675
0.9	.218	.220	.230	.249	.273	.300	.329	.359	.388	.416	.443	.492	.536	.574	.608	.639
1.0	.198	.199	.209	.226	.249	.274	.302	.330	.358	.386	.412	.460	.503	.541	.576	.607
1.2	.166	.167	.176	.191	.211	.234	.259	.285	.311	.336	.360	.406	.448	.486	.520	.551
1.4	.142	.144	.152	.165	.183	.204	.227	.250	.274	.298	.320	.364	.404	.440	.473	.504
1.6	.124	.126	.133	.146	.162	.181	.201	.223	.245	.266	.288	.329	.367	.402	.435	.464
1.8	.110	.112	.119	.130	.145	.162	.181	.201	.221	.242	.262	.301	.337	.375	.402	.430
2.0	.100	.101	.107	.118	.131	.147	.165	.183	.202	.221	.240	.277	.311	.343	.374	.401
2.2	.090	.092	.098	.107	.120	.134	.151	.168	.186	.204	.221	.256	.289	.320	.348	.375
2.4	.084	.085	.090	.099	.110	.124	.139	.155	.172	.189	.205	.238	.269	.299	.327	.353
2.6	.076	.078	.083	.091	.102	.115	.129	.144	.160	.176	.192	.223	.253	.284	.308	.333
2.8	.072	.073	.077	.085	.095	.107	.120	.135	.149	.164	.180	.209	.238	.265	.291	.315
3.0	.066	.068	.072	.079	.089	.100	.113	.126	.140	.155	.169	.197	.224	.251	.275	.300

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3. Soft valve seat insures positive shut-off, virtually no crawl.
4. Light weight and heavy duty.

MODEL	GAS DELIVERY	MAX. FLOW	PRICE
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25P	Ac. & Prop. 0-25	400	19.25
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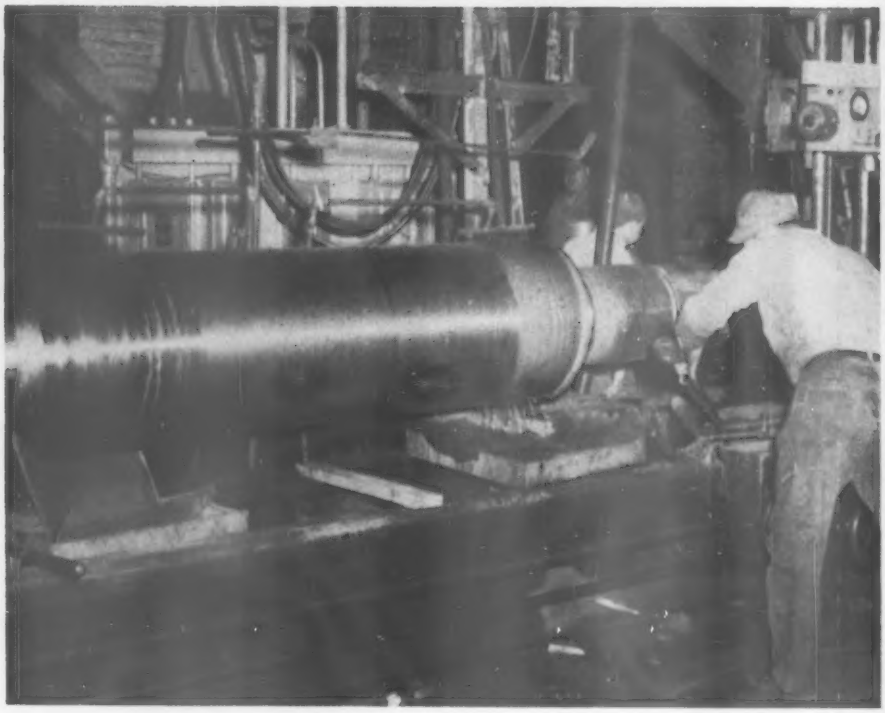


This scored, worn and pitted roll won't give economical service unless it's repaired; it will ruin strip—even shut down a mill. That's why Midvale-Heppenstall developed . . .

Techniques For Crack-Free

IN BRIEF: Mill rolls will last years with proper care. To overhall them you must know their chemistry and properties. And, you must have carefully worked-out welding and grinding techniques.

ROLLING MILL ROLLS may look indestructible but they're not. Being made of the most suitable materials, expertly heat treated and finished to exact dimensions doesn't stop rolls from wearing out. Constant regrinding is needed to keep the product finish good. The soft roll body won't hold its finish and the blemishes will transfer to the product—steel, copper, aluminum, brass, or paper. Badly worn and scored journals can even halt the mill—and there goes your production.

Rolls will last for years with the right care. They'd better, because they are a big item in the cost of a rolling operation. The question is, how do the rolling mills make them last?

RECORD EACH ROLL'S HISTORY

They go to a specialist, the Midvale-Heppenstall Company of Philadelphia. This company makes new rolls in their big forging and machine shops and they rework old ones. They know their rolls from the ladle to the grave. They keep each roll's history like a doctor keeps the medical history of a patient. They record the chemistry, forging history, heat treatment, and machining and grinding operations on each roll.

Regrinding eliminates imperfections, restores the surface and the crown a roll should have. But the grinding operator must take care. He removes just a few thousandths of metal at a time. A deeper cut might overheat the surface, cause spalling, or ruin the roll.

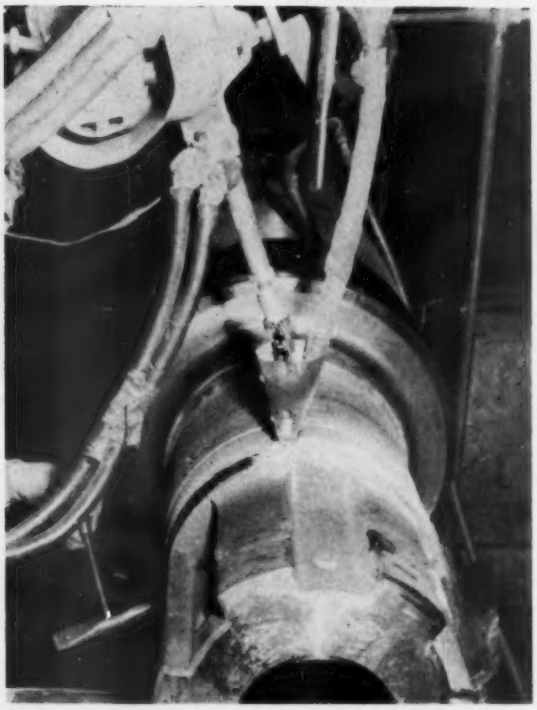
CAN'T GRIND TOO OFTEN

There's a limit to the number of times a roll can be reground. If the diameter gets too small the surface will be too soft for practical use. Rolls that have reached this condition can be salvaged by rehardening.

When Midvale-Heppenstall reconditions a roll they often build up the journals at the same time. Sometimes rolls come in for rehardening with the journals so badly scored and worn that they are not fit for use unless they are built up.

A typical roll has a 16-inch-diameter journal, a 2-foot-diameter body, and is 5 to 10 feet long. Larger rolls have 3-foot-diameter journals and weigh more than 100 tons. One grade of roll steel has a nominal composition of 0.85 carbon, 1.90 chrome, and 0.23 moly. This is a crack-sensitive material and must be preheated before welding.

FIRST LAYER: Shallow penetration is obtained using low hydrogen electrodes and low amperage.



SECOND LAYER: Crack-free submerged arc welds are obtained by keeping most of the puddle on the previous pass.

Surfacing Of Mill Roll Journals

Midvale-Heppenstall mounts the roll in a 25-foot-long lathe. Close by are power sources for manual welding and for automatic submerged arc welding. The submerged arc head, flux hopper and wire feed are mounted on a powered manipulator so that the head can travel in unison with the revolving journal. The station also has air, gas, and water lines to heat and cool the roll.

First they heat the journal to temperature with an air-gas torch. Temperature-indicating sticks tell the operator when it's hot enough. During heating, running water cools the roll body next to the journal to keep it below the draw temperature. If it gets hotter, the body would lose hardness.

The operator puts the first layer on the journal with E7016 low hydrogen electrodes. He deposits the second, a heavier layer, with submerged arc. This procedure limits penetration, and therefore dilution of the first layer with the base metal. And it serves as a base for the automatic weld.

PENETRATION IS AVOIDED

Submerged arc welding does an immaculate job on the journal. Besides being good looking, the weld is crack free and can be machined to a mirror finish. With a weld width of ¾ inches and a travel feed of 3/16 inches per revolution, the arc is concentrated on the previous bead. Thus, most of the penetration is carried on the previous bead and, too much base metal dilution is avoided. The company found long ago that if they moved over as much as half the width of the bead, they chanced cracks.

Having the head just in front of center helps limit penetration too. The molten metal crowds the arc puddle providing further insulation against deep penetration. This position also prevents slag spillage and poorly shaped beads.

Power for submerged arc welding comes from two 650-amp a.c. welders. Wire is usually 5/32-inch 0.13 carbon and 1.95 manganese. Head travel is 15 ipm.

STRESS RELIEF

After both journals are built up, the roll is heated to relieve weld stresses and to reduce weld zone hardness. This is done right on the lathe by heating the weld area to between 900 and 1,000°F for 12 hours. This operation is done carefully to insure good service under severe stresses. After stress relief, machining. The operators turn and grind the roll necks to new-roll tolerances.

Midvale-Heppenstall's welding procedures are so successful, they haven't lost a roll for many years because of welding defects. • •

The product . . .

TWO DIFFERENT ALUMINUM alloys are used in dump trailers. Higher strength alloy is used in underframe and body stress points.

The welding . . .

LIGHTWEIGHT, PORTABLE GUN increases welding efficiency. Trunnion fixture (right) permits welding tailgate in downhand position.

Welded Aluminum Trailers

IN BRIEF: Lightweight aluminum dump trailers increase payloads as much as 4,000 pounds; they resist corrosion, clean easily and need little upkeep.

WELDED ALUMINUM dump trailers made by Lodestar Corporation, Niles, Ohio, make trucking and hauling more profitable. These lightweight trailers weight about one-third what a steel dump trailer does and increase payloads by as much as 4,000 pounds. They resist corrosion, clean easily and need virtually no upkeep, except for usual preventive maintenance.

TWO ALUMINUM ALLOYS

Lodestar uses two different aluminum alloys in their trailer dump bodies: 3/16- to ½-inch 6061-T6 and 5/32- and 3/16-inch 5154-H34 and H32.

The 6061-T6 alloy used in the underframe and other body stress points has a higher strength (42,000 psi ultimate tensile and 35,000 psi yield strength) than the 5154 alloy. It contains 0.25 copper, 0.6 silicon, 1.0 magnesium and 0.25 chromium.

The 6061-T6 alloy is solution heat treated to produce stable tempers (with or without supplementary strain hardening). The T6 indicates solution heat treating with a specific combination of basic operations, including cold working, natural and artificial aging. The T6 designation applies to alloys which are artificially aged after solution heat treatment, but not cold worked. The effect, if any, of flattening or straightening is not recognized in applicable specifications. Whether flattened or not, 6061-T becomes 6061-T6 when artificially aged

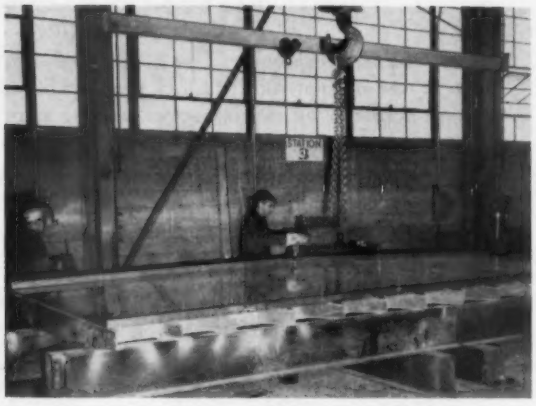
The 5154 alloy is not quite as strong as the 6061-T6 alloy; its ultimate strength is 40,000 psi and its yield strength 33,00 psi. It is used for the floor plates (H34 temper) and for the remainder of the body H32

Careful preparation of parts is key to successful welding . . .

BAND SAW is one of three sawing tools used; others included an electric hand saw and a hand jig saw.

MECHANICAL SHEAR gives clean cuts with few burrs on aluminum sections up to one-inch thick.

UNDERFRAME IS GROUND (above) to get good fit-up with floor plate which is welded to it. Prebowing the underframe



(above) compensates for warping caused when floor plate is welded to it.

Carry Bigger Payloads

temper), including side panel sheets, vertical reinforcing members and tail gates.

The properties of this magnesium-containing alloy (3.5 magnesium and 0.25 chromium) is stabilized by a low temperature heating after strain hardening. This is indicated by the H3 designation. This heating reduces the strength of the alloy slightly, but increases its ductility. If the treatment were not employed, the change of properties occurs over a long time at room temperatures.

The "2" in the H32 and the "4" in the H34 indicate the degree of cold work performed on the alloy. With "8" representing the hardest commercially practical temper, "2" means quarter hard and "4" is half hard.

PORTABLE WELDING GUN

Lodestar uses a portable gun to increase efficiency of welding with the consumable electrode gas shielded process. The gun and its controls weigh only four pounds when loaded with one pound of welding wire and can be easily carried to distant work sites.

The gun has an integral motor-driven wire drive and wire supply. A high torque air-cooled DC motor in the gun's handle drives a knurled feed roll that pulls filler wire from a fiber reel at the gun's rear. A push button in the handle inches the filler wire. Gun uses from .020 to 1/16-inch diameter wire and gives travel speeds on horizontal fillets up to 22 ipm.

Welds are made in one pass whenever possible. Joints are mostly fillets; some laps are used for greater strength.

Welding is done at 20 ipm, using 165-195 amps of direct current reverse polarity. Argon shield gas flows at 35 cfh. Wire feed is about 220-240 ipm. Two types of 3/64-inch diameter wire are used: 5156 for the 6061-T6 and 4043 for the 5154-5454.

Trailer body components, including underframe,

continued on page 71

Are you paying

5 TO 10 TIMES TOO MUCH FOR WELD INSPECTION

. . . . and not finding ALL the cracks?

If you are testing to routine specifications—or applying such specs—it is quite likely that you are paying an unnecessary high price. Certainly it is a possibility worth investigating!

With Magnaflux testing . . .

you can reliably inspect about 150 feet of linear welds per hour, at a cost of approximately 4.4¢ per foot of weld. This includes man-hour cost for two inspectors working at an *average* rate, plus the small cost of Magnaflux powder used.

For non-linear welds, your cost will be about 50% more—or roughly 6.6¢ per foot of weld, including normal cost and time for moving scaffolding.

Compare these costs with what you are paying now!

How reliable is Magnaflux?

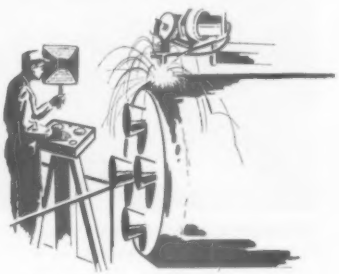
It is the only recognized test proven completely reliable for finding all cracks open to the surface . . . however small or deep. These are the cracks that raise stresses dangerously and cause most of the failures in weldments.

Many manufacturers of X-ray equipment frankly caution that X-ray may not find all these cracks. Yet, these very cracks are most important to find! Nor will *any other method* find them at a cost as low as Magnaflux.

None of this implies that Magnaflux testing eliminates all need for other test methods. Magnaflux *can* cut your testing costs and it *will* find many cracks other methods overlook, and the significant sub-surface defects, as well.

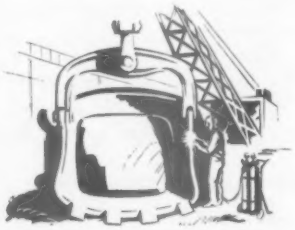
Shouldn't you investigate these savings now? Ask to have a Magnaflux Engineer detail the whole story—soon.

CONSTRUCTION: Bridges, buildings, etc. Magnaflux is proved out on important welds.



SPACECRAFT: Critical welds. Often several Magnaflux and other methods needed—on each weld.

OIL and CHEMICAL: For pipeline, reactor, or tank—welds proved crack-free.



HEAVY EQUIPMENT: Manufacture and Repair. Portable and low cost reliable tests.

MAGNAFLUX CORPORATION

A Subsidiary of General Mills

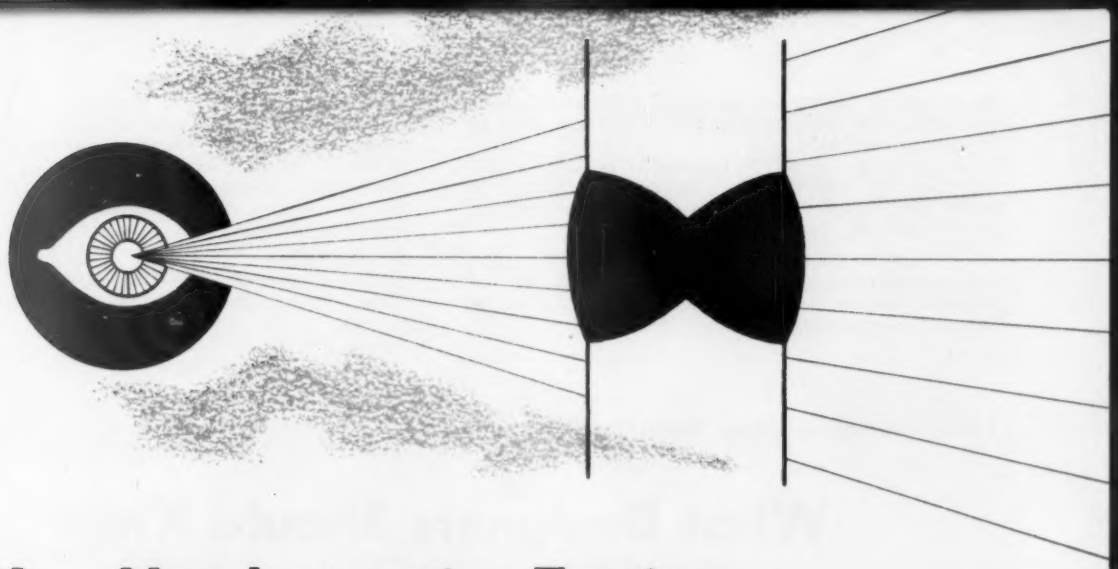
7348 West Lawrence Avenue, Chicago 31, Illinois

New York 36 · Pittsburgh 36 · Cleveland 15

Detroit 11 · Dallas 35 · Los Angeles 22

The Hallmark of Quality in nondestructive test systems

For More Information Circle No. 44 on Reader Service Card.



How Nondestructive Testing Aids In Designing For Welding

IN BRIEF: A thorough knowledge of the various nondestructive testing methods can help in the design of low-cost, efficient weldments.

THERE ARE THREE THINGS a designer—or anyone connected with the design of weldments—must know about nondestructive testing: *Why test? When?* and *How?*

WHY TEST?

It's a three part answer.

First, the designer must develop a welded design that can be produced at a reasonable cost and will perform its function for a specific period of time. You need quality manufacturing to do this—and the one big, consistent check on quality is nondestructive testing. The testing shows up weld defects.

Second, nondestructive testing is usually required because a product is made according to a code. This means design people must know the various codes that establish the required tests. Codes are set up by:

ASME: Welded boilers and pressure vessels are regulated by various ASME codes. (See page 44 for an article by Westinghouse X-Ray's Walter Hampe on how radiography permits the use of thinner sections in pressure vessels.)

AWS: "Standard Code for Arc and Gas Welding in Building Construction" controls welded fabrication of steel frame buildings. It is accepted by the AISC, whose codes cover the design, fabrication, and erection of the entire structure.

"Standard Specifications for Welded Highway and Railway Bridges" covers design and fabrication of welded bridges. It is used with standards set up by the American Association of State Highway Officials (highway bridges) and the American Railway Engineering Association (railway bridges).

ASA: "Code for Pressure Piping" covers welded transmission lines for oil, gas and air.

ASTM: Codes cover specifications for steel and other structural metals. Designation A-7 is for structural members; Designation A283 is for details.

Insurance codes: Most companies use ASME codes. Occasionally they accept other applicable codes.

Military codes: All branches have their own.

Finally, many companies test finished product just to be on the safe side. Companies like General Motors' Euclid Division test axle assembly welds to make sure they're sound—not because of any code requirements.

And, stress engineers in the aircraft industry often use spot X-ray tests to get information about welds in critical stress areas.

WHEN TO TEST?

Most testing is done after welding. However, it is not unusual to test during welding. For example, welding operators can use dye penetrants or magnetic particle inspection to check each pass of a multiple pass weld. This minimizes the risk of a weld not passing final inspection. It also cuts down on expensive grinding and rewelding that are necessary if defects turned up during final inspection.

Actually, the most important *time* in nondestructive testing is the time a product is being designed. Roy McCauley, head of the Ohio State University Department of Welding Engineering, says nondestructive testing must be designed into a product. Prof. McCauley feels the worst thing is to tack it on after a product has already been designed for welding or perhaps redesigned from riveting to welding. He thinks nondestructive testing should also be used in the early design stages to help develop sound welding procedures.

Manufacturers can save time and money by designing a product so it can be tested efficiently after welding. For example, it's cheaper and easier to make tests if you don't have to remove, repair and replace parts. Furthermore, a man who knows nondestructive testing techniques will, often during design, be able to alter a design inexpensively and thereby simplify and reduce inspection costs.

HOW TO TEST?

The consensus is that designers should try to know everything about nondestructive testing. They must know methods, applications, limitations, and even techniques (see nondestructive testing guide on page 41). They should know there are many tests, but that each does a certain job best and most economically.

The designer must choose (when he has a choice) the process best suited to the job—the most economical one which will reliably show the defects considered harmful.

This sounds like a tall order for a complicated and specialized subject like nondestructive testing. But, the design engineer should try to make himself an authority

on the subject. Better yet, he should make sure there is someone in his company that design men can refer to when they need help.

Design people usually *are consulted* on the use and purchase of nondestructive testing equipment—even when their companies have big, well-staffed inspection departments. For instance:

- At GMC's Euclid Division, designers work with welding engineers and metallurgists. Generally they determine what products should be tested and how on the basis of what equipment is available.
- At another fabricator, designers review drawings and decide on test requirements. Then they check to see if equipment with suitable capacity is available. If it isn't, the designers sometime suggest a design change. Or, a customer is asked to approve the use and cost of special testing equipment needed to meet contract specifications.
- At a Midwest aircraft plant, designers are encouraged to recommend any testing method they have heard about. These methods are then evaluated for possible use. • •

these comments from industry leaders explain . . .

What Designers Should Know About Nondestructive Testing

- **John A. Reynolds, technical director**
- Picker X-Ray Corp., White Plains, N. Y.

"Industrial uses of radiation, whether by X-rays or radioisotopes, are limited only by human ingenuity and imagination and will expand sharply this year.

"The critical need for perfection in the components of such modern devices as nuclear reactors, missiles and space vehicles has done much to stimulate the growth of radiography for nondestructive testing. However, the use of radiography is also growing rapidly in such familiar fields as the construction of aircraft, pipelines, ships, bridges and boilers.

"Welding, for example, was a skill that relied on the reputation of the welding operator. Now the demands of industry are such that the integrity of the weld must be proved by testing. The slight expense of radiography is usually more than offset by material and time savings.

"Now, as successive stages of fabrication are completed, radiography is often the only way to make sure the job has been done properly. And, radiography is again a must when a finished product must be inspected to get final proof that no flaws remain to cause trouble when the product is in use."

- **A. G. Sherwin**
- Met-L-Chek Co., Los Angeles

"Our nondestructive testing process, the visible penetrant process, can be used to detect surface connected flaws. It is relatively simple, extremely effective, fast and requires no elaborate equipment. And, the operator can check his own work.

"Designers should know that some penetrants contain dangerous amounts of sulfur and chlorine. These have a bad effect on stainless steel and can cause sulfur embrittlement and chlorine stress corrosion."

- **Frank B. Self, vice president,**
- Pioneer Industries, Fort Worth

"I feel insufficient attention is given to testing by many major airframe and spacecraft manufacturing plants. Very little money seems to be spent for improving testing facilities and correlating research results.

"It is hard to believe that some manufacturers will refuse to employ a testing device that gives a positive evaluation of braze quality and strength in honeycomb panel construction merely because there is a possibility of damaging what is actually a defective panel to begin with. But, this has been my experience. It seems to me that it would be better to discover in the beginning that a panel and primary structure component will fail below the design limit of heat and stress, rather than wait until the finished plane or missile collapses in the air.

"It seems in many cases that production facility people simply do not understand the importance of nondestructive testing."

- **E. Alfred Burrill, vice president**
- High Voltage Engineering Corp., Burlington, Massachusetts

"In general the radiographic examination of welded joints is an added production cost; in the direct sense it does not lead to savings in construction. But, radiographic inspection of welds is important because it assures higher quality of construction and probable higher strength of the joint. For instance, in the engineering testing of certain highly stressed assemblies, such as jet engines, the failure of a weld during test can result in time-consuming effort or even extensive damage. In addition, the latent defects in a weld may be uncovered after grinding or machining the weld smooth. Radiographic inspection can eliminate the time wasted in machining a defective part."

Burrill

- **Harry E. Smith, manager, Dy-Chek Division**
- Turco Products, Inc., Los Angeles

"The dye penetrant inspection method can be used by itself. Or, it can be used in conjunction with other inspection media.

"Used by itself, our Turco Dy-chek penetrant method is an excellent means of detecting defects extending entirely through welded section. And, when the final inspection medium is radiography or a non-portable process, welds can be inspected with dye penetrant after each pass. This eliminates expensive grinding that would be needed to remove a defect found in final inspection, And, it virtually eliminates the possibility of a weld failing to pass final inspection."

more industry comments on page 42

Guide to nondestructive testing...

GAMMA RADIOGRAPHY

APPLICATIONS

Used mainly to inspect the interior soundness of all metals. Detects internal defects in welds: gas porosity, slag inclusions, incomplete penetration, cracks, icicles and burn-through; also used on castings, forgings, and worked and formed metal parts.

ADVANTAGES

Shows size and nature of hidden flaws or discontinuities in different thicknesses of metallic and non-metallic materials; gives a permanent, graphic record of defects. Has established standards, is easy to interpret and is accepted by the government and private agencies.

Needs no electrical power sources nor oil- or water-cooling.

Process is more portable.

Smaller source holder permits use on intricate or complex jobs.

It can be used for panoramic techniques that might not be possible with X-ray.

Initial cost is relatively low.

Shows up defects on a wider range of metal thicknesses on the same radiograph.

LIMITATIONS

Energy cannot be adjusted; isotope must be chosen to meet the sensitivity requirements of a particular type and thickness of material. Radiation source cannot be turned off; a government license is needed for possession and use of isotopes.

Sensitivity is not as great as with X-ray.

Fluoroscopy techniques are normally not available.

Not as good as X-ray for extremely thin sections.

Trained technicians are needed.

MAGNETIC PARTICLE

APPLICATIONS

Used to detect cracks that result from fatigue, thermal stresses, gas pockets, lack of fusion and slag inclusions in ferromagnetic materials.

ADVANTAGES

Positive method for finding crack-like defects at or close to the surface. Method is flexible and economical. Portable equipment is available. It can be setup for continuous production-line inspection.

LIMITATIONS

Limited to ferromagnetic materials.

No indications apparent for cracks parallel to the magnetic field so magnetism for two directions is needed to find all discontinuities.

Surfaces must be clean and dry; surface roughness decreases sensitivity.

Process is not suited for deep-seated small defects.

PENETRANTS

APPLICATIONS

Used to locate surface cracks, porosity and leaks in nonporous solids; metals, ceramics, glass and most plastics. Used in production dip tanks or with portable kits.

ADVANTAGES

Detects extremely minute cracks and leaks. Dye penetrant appears as a deep red on white background; fluorescent penetrant glows brilliantly under black (ultraviolet) light.

Simple, accurate, fast. Low installation and per-item cost.

LIMITATIONS

Not effective on subsurface defects.

Surfaces must be free from oil and grease.

A semi-darkened area is necessary for good inspection with the black light. Portable kits require electricity.

ULTRASONIC

APPLICATIONS

Used on weldments, castings and forgings, on plate and sheet metal, rods, bars and tubes. Two forms are available: One (resonance) is used for gaging thickness and detecting thinning due to corrosion. The other (pulse-type) finds internal defects, including cracks, poor bonding, inclusions and laminations. Used to inspect long distances in metal and on large pieces.

ADVANTAGES

Speedy process gives instantaneous, easy-to-read information on size, locations, orientation and degree of flaw. It allows inspection from one surface and gives clear indication of sub-surface defects over a range of depths up to 25 feet.

Equipment is mobile, light and relatively inexpensive.

Accuracy is not affected by radiation, temperature and pressure.

In measuring thickness, instantaneous readings are obtained in thousandths of an inch with an accuracy of two percent of thickness. Lends itself to automation.

LIMITATIONS

Power source is necessary and photographs must be taken for permanent records.

Total immersion of parts is required with some types of equipment.

It is not usable on "as cast" or "coarse grain" materials nor on small, irregularly shaped parts.

A couplant (oil, glycerine or water) must be used to provide a path for the ultrasonic waves. Technicians need training in interpreting and analyzing defects.

X-RAY

APPLICATIONS

Used mainly to inspect the interior soundness of all metals. Detects internal defects in welds: gas porosity, slag inclusions, incomplete penetration, cracks, icicles and burn-through; also used on castings, forgings, and worked and formed metal parts.

ADVANTAGES

Shows size and nature of hidden flaws or discontinuities in different thicknesses of metallic and non-metallic materials; gives a permanent, graphic record of defects. Has established standards, is easy to interpret and is accepted by the government and private agencies.

X-ray energy can be adjusted for use on a variety of materials and material thicknesses.

Radiation source can be turned off when not in use.

Generally gives greater sensitivity than gamma techniques.

Fluoroscopy techniques are usually available.

Better than gamma for use on extremely thin sections.

LIMITATIONS

A power source and oil- or water-cooling is needed.

Size and weight are generally larger than gamma equipment.

More difficult to position on intricate or complex jobs.

Does not work as well as gamma on panoramic exposures.

Initial cost is relatively high.

Shows up defects on a narrower range of metal thickness on the same radiograph.

Trained technicians are needed.

- **E. W. Philleo, industrial marketing manager**
- X-Ray Dept., General Electric Co., Milwaukee

"The design engineer must bring about a balance between the improvement of manufacturing techniques and the need for rapid, accurate inspection procedures. X-ray will help him do this. Under X-ray's infallible eye, scrap losses and rejections should hit new lows, development time should be shortened and the risk of using sub-standard parts minimized.

Philleo

"The design engineer should be aware of the four basic classifications of quality control and analysis. These are:

"Gaging: The mass of the material and hence its thickness is measured by the absorption or scattering of a beam of radiation.

"Localization: Any abrupt change in the absorption of the material caused by a flaw or an occlusion is detected.

"Structure analysis: Radiation finger prints a compound by determining the crystal structure unique to it.

"Elemental analysis: Excited secondary radiations are used to identify certain elements with relative simplicity at high speed.

"The low energy X-ray generator-detector system is becoming more important in gaging, while the X-ray scanning transducer is opening new areas for complete automatic inspection.

- **John E. Bobbin, sales manager**
- Branson Instruments, Inc., Stamford, Conn.

"Designers should know that ultrasonic inspection can supply them with fast, low cost and detailed information about weld quality. New portable instruments permit inspection of welds right on the production line—immediately after they have been made. The test is almost instantaneous and the results are available as the test progresses.

"The overall cost of ultrasonic weld inspection is extremely low. Only a small capital investment is needed and recurring expenses are negligible. The high testing speed contributes to a low cost per foot.

"Another important fact: Ultrasonic inspection can find many serious flaws with relative ease. Among these are tight cracks, lack of fusion and lack of penetration. This is important because these flaws sometimes exist at angles unfavorable for detection by conventional radiography.

- **A. J. Stevens, president**
- Radiation Engineered Services, Norristown, Pennsylvania

"A designer must know the methods, applications, limitations and even techniques of every useful means of nondestructive testing. He must also know what codes and specifications apply to his field. In short, he must know everything about nondestructive testing.

"After all, a designer's first responsibility is to provide a solution to a problem. But, no solution is of any value unless it works. And, no design can be guaranteed to work unless it is tested—nondestructively.

"Take the design of a large, reasonably complex pressure vessel. The designer can save material by knowing applicable codes. And he can often save fabrication costs by making proper provisions for radiographic inspection during construction. Or, his knowledge of nondestructive testing techniques will help him make relatively inexpensive design alterations that will simplify and reduce the cost of inspection."

"Just remember that during a 12 month period in 1957-1958 the use of isotopes in industrial radiography saved industry $2,800,000."

- **Franklin S. Catlin, manager marketing development**
- Magnaflux Corporation, Chicago

"Designers should know there are a large number of nondestructive tests used on weldments or structures. Each of these does a certain job best. None of the tests will do the complete nondestructive testing job, nor is any one the best and most economical for all jobs. For example, on pressure vessels, both Magnaflux and X-ray are often used. The magnetic particle inspection finds cracks at or near the surface which are critical from a stress point-of-view. The X-ray is used for deep-surface defects where its advantages are unique.

"The best test for many structures may be dye penetrant, or Zyglo fluorescent penetrant, or ultrasonic for checking defects or for measuring thicknesses. And, we are now using our Magnatest eddy current instruments along the sides of welds to map out the heat affected zone, where excessive heat affect may be serious, as on aluminum tanks for use in missiles.

"Nondestructive testing has become more and more complex. The designer should attempt to make himself an authority on the subject. Or, someone in the designer's company should be designated to know nondestructive testing and serve as an advisor to those design men who need to know the best test for a specific job."

- **Marcel Marechal, vice president**
- Balteau Electric Corp., Stamford, Conn.

"Designers of welded fabrications should know these facts about X-ray inspection:

"X-ray inspection permits the reduction in steel thicknesses required by assuring 100 percent weld joint efficiency. This reduces weight and cost of steel, labor, cost of welding and handling expenses.

Marechal

"Random radiographic sampling of an operator's work has a good psychological effect. Operators will do the good job they are capable of if they know they are being checked by radiographs. And, qualification and certification of operators can be done by relating samples of production work to each operator. This eliminates making time-consuming sample welds which the operator knows are going to be checked.

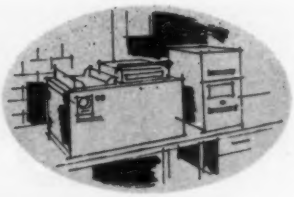
"X-ray inspection will facilitate approval of new welding designs in the lab or in the field.

"Designers should make sure their structures are made so that they can be X-rayed effectively."

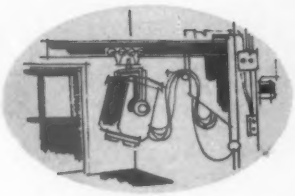
more industry comments on page 44

Nine different ways...

TVX
remote-inspection unit

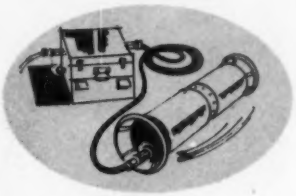


Xeroradiographic unit for
dry-process radiography



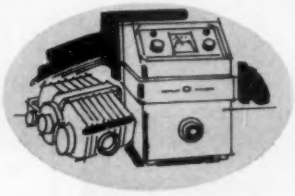
OX-250 general
utility x-ray unit

Resotron 300*—
300-kvp portable x-ray

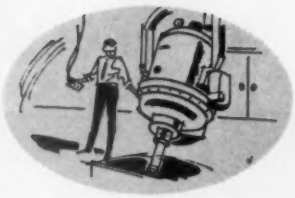


OX-175 — 175-kvp
portable x-ray

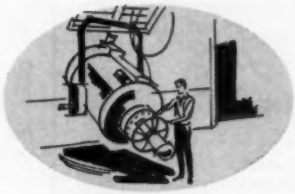
LX-140 — ultra-compact
portable x-ray



LC-90 lightweight
mobile x-ray



Resotron 1000*—
million-volt x-ray



Resotron 2000*—
2-million volt x-ray

to look at your products!

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G-E x-ray inspection equipment covers every need — with units available in power ranges from 5 to 2,000-kvp output . . . choice of wet or dry radiographic processing . . . even *remote-television* x-ray fluoroscopy. Production-line, continuous inspection can easily be arranged where desired.

There's no need at all to settle for piecemeal help when you want x-ray apparatus, supplies or installation-planning assistance. Instead, take advantage of the industrial x-ray experience General Electric has gained through half a century of serving needs and solving problems much like your own. You stand to come out ahead in many ways. Our specialists have the knowledge that can find right answers in a hurry. Our research facilities are set up to solve even the most unusual puzzles.

For assistance with your inspection problems, contact our office in your area, or just write X-Ray Department, General Electric Company, Milwaukee 1, Wisconsin, Room WD-34.

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INDUSTRY COMMENTS *continued*

- **Walter Hampe, testing consultant**
- Westinghouse Electric Corp., X-Ray Dept., Baltimore, Md.

"Trepanning (a plug sawed out of a weld section for macrograph or micrograph inspection) is no longer an acceptable method of spot inspection of welds for 'Unfired Pressure Vessels'.

Hampe

"Fabricators of these ASME Code vessels will have to conform to one of three following production requirements.

"One hundred percent X-ray inspection of all welds where minimum tank wall thicknesses are used.

"X-ray spot check of prescribed areas. For example: six inches of every 50 feet of welds.

"Use of heavier steel.

"This means nearly every fabricator will go to X-ray inspection. The thinner plates permitted will produce a savings in material, fabrication, handling and shipping that will far outweigh X-ray inspection costs.

X-RAY SAVES $400

"One Midwest tank manufacturer reports: 'It costs about $200 to X-ray a 30,000 gallon tank. This includes film, chemicals, labor and depreciation. But, gross savings are approximately $600 a tank, so the net savings is $400.'

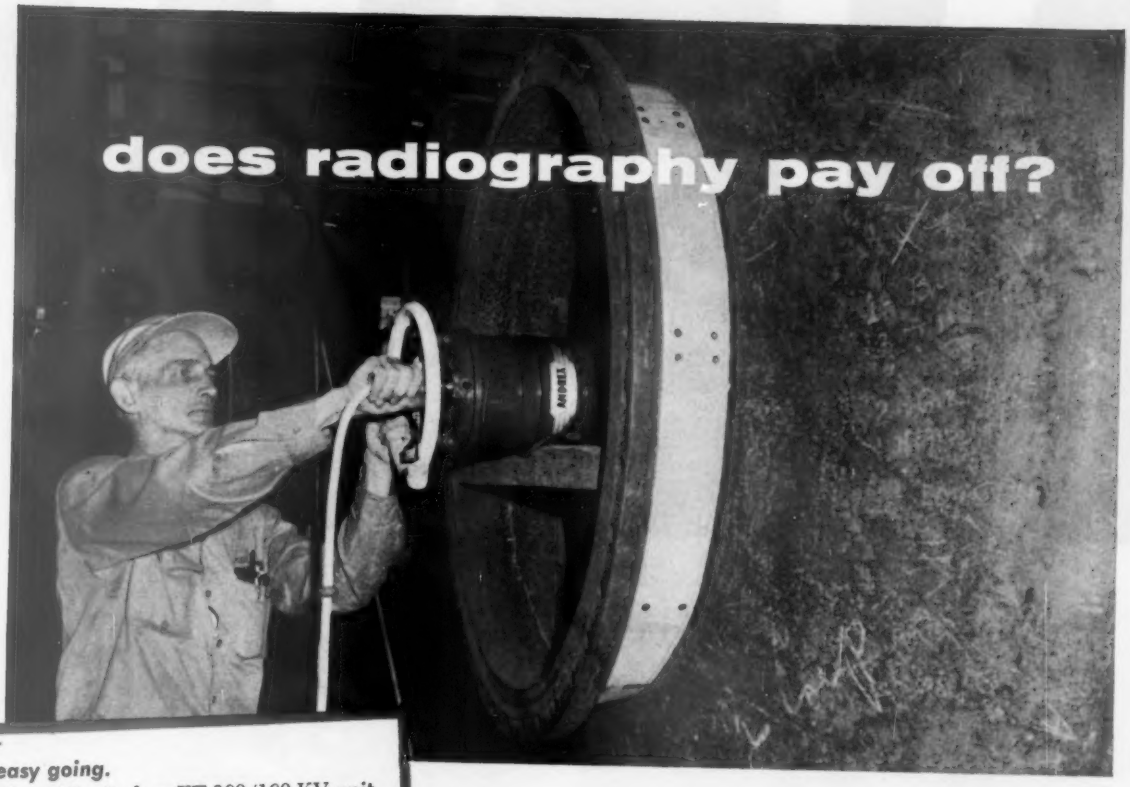
"Three things determine the shell thickness of a tank: the working pressure, the outside diameter of the tank and the efficiency of its welded joints.

The joint efficiency depends on the type of joint and the degree of examination of longitudinal and circumferential welds. This means if welds are 100 percent radiographically inspected and found to be acceptable according to the Code, they would be considered 100 percent efficient. Example: If working pressure and diameter call for a 0.5 inch wall and if all welds are completed inspected by X-ray and are satisfactory, the manufacturer could use 0.5 inch shell or plate thickness.

On the other hand, if the manufacturer only spot checks the welds with X-ray, then the joint efficiency can be considered only 85 percent sound and the tank must be fabricated from steel plate 15 percent heavier, or 0.59 inches thick (0.5 divided by 0.85 equals 0.59).

"If neither 100 percent radiography or spot examination are used, the fabricator must use a 70 percent joint efficiency. In this case the wall thickness would 0.5 divided by 0.70 equals 0.71 inches."

does radiography pay off?



easy going.
The 64 lb. Andrex FT 360/160 KV unit here emits full-circle radiation: it will radiograph the entire girth weld of a vessel in one "shot". Films are held in place by a snap-on canvas band circling the neck.

x-ray is best for some jobs.
In that case the right machine for you probably lies somewhere in the comprehensive range of x-ray units listed below.

gamma ray (from radioisotopes) is better for others.
With one machine or another in the broad Picker line of isotope units you can radiograph anything from thin aluminum up to 10" thick steel.

unbiased advice free for the asking.
With an equipment line like that (nothing like it in the field) we have no axe to grind for any particular kind of machine: we can *afford* to be unbiased.

Does radiography pay off? Ask steel tank and pressure vessel fabricators—from now on in they couldn't *live* competitively without it.

Look: the new ASME code, Section VIII, ascribes 100% efficiency to a welded joint radiography-proved sound: the weld is considered strong as the mother metal even without stress-relieving. Which means that steel thickness of a radiographed vessel can be less than the thickness of a non-radiographed one.

Ergo: radiography can save tons of steel.
Ergo: radiography saves far more than it costs.

An extreme example? Hardly: hundreds of case records are as dramatic. Call in your local Picker man to find out what radiography (or fluoroscopy, maybe) can do for you. You'll find Picker offices in all principal cities (see local phone book) or write or wire us at the address below.

PICKER X-RAY CORPORATION
25 South Broadway, White Plains, N. Y.

Picker x-ray

one stop for everything in industrial radiography

ANDREX	portable x-ray units—140 KV, 160 KV/360°, 200 KV, 260 KV
PICKER	x-ray units—35 KV Beryllium window, 110 KV, 150 KV (stationary and mobile), 270 KV portable, intensified image fluoroscopes
TECH/OPS	units for isotope radiography—sources, equipment, containers for Iridium 192 Cobalt 60 Thulium 170 and Cesium 137
ACCESSORIES	... films, tanks, darkroom sundries, illuminators, *everything*

For More Information Circle No. 56 on Reader Service Card.

NEW

Ansco Superay 'D'

An ultra-speed x-ray emulsion specifically designed for use with intensifying screens of calcium tungstate types

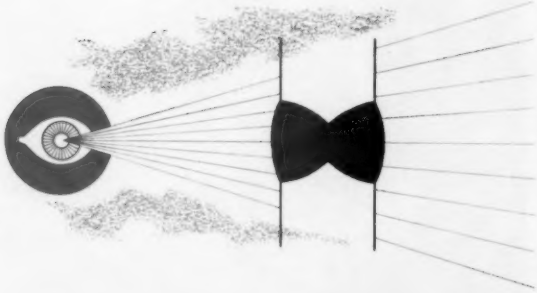
Here at last is an all new fine grain film that has extremely wide latitude when exposed either by direct x-rays or with lead screens.

Try this superb new film and see the consistently superior results in flaw detection through specimens having a wide range of thicknesses. All this plus higher performance with calcium tungstate intensifying screens to increase speed, make Ansco Superay 'D' ideal for testing heavy metals with low voltage equipment. Ansco, Binghamton, N.Y., A Division of General Aniline & Film Corporation.

Ansco

Industrial X-ray

For More Information Circle No. 25 on Reader Service Card.



IDEAS ON WELD TESTING

for Inspectors, Metallurgists, Quality Control Men, Designers

The case histories which appear on the next 10 pages are only a few examples of how industry uses nondestructive testing to check the quality of welded and brazed products.

INSPECTOR CHECKS X-ray set up (left) before making exposure (right) of tank seam.

Tank fabricator uses 140 KV portable X-Ray unit to speed in-the-shop and in-the field inspection

PORT ARTHUR, TEXAS: A single, portable X-ray machine is used by Ellerbee Brothers, tank designers and fabricators, as a dependable, versatile radiographic testing tool. It is used both in the shop and in the field.

The Balteau Baltospot 140 unit has been in constant use by Ellerbee since March, 1957, for inspection of plates from 3/16-inch up to 1½-inch thick. Techniques vary from small spot X-rays on light plates to inspection of heavy plates at long focus film distances, using extra-long films for large, single exposure coverage.

All work is covered by one of the following specifications: API Code 12 C for large storage tanks, API Code 620 for low pressure storage tanks and ASME Code for pressure vessels.

Every X-ray film becomes a permanent record. It is filed and a shell plate layout of the exact location of each exposure is made and stored. This is information is sometimes required by Ellerbee's customers at a later date.

The Baltospot is a 140 KV unit capable of penetrating 1¾-inches of steel. It weighs 48 pounds; the control panel weighs 26 pounds.

Power for operating the unit in the field is taken from the customer's regular outlets or from a small 3KW portable generator or from a transformer built into one of Ellerbee's large 100 KW generators used to run welding machines. • •

Heat transfer is key to new test procedure for honeycomb panels

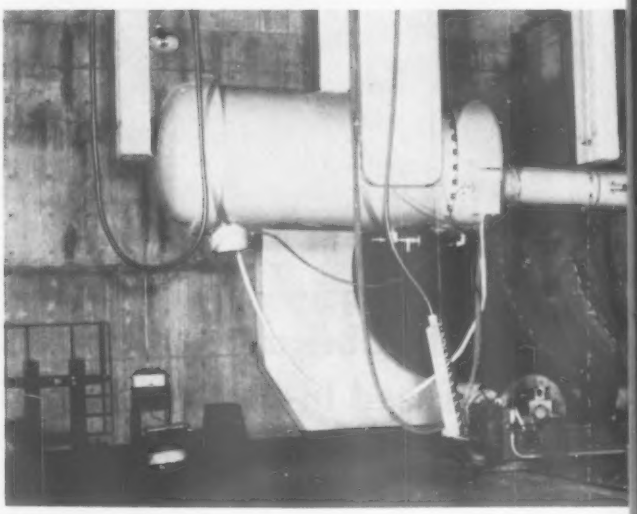
TYPICAL HONEYCOMB panel is placed on conveyor (curved panel is used for demonstration purposes).

LOS ANGELES: A test procedure for detecting flaws in honeycomb materials used in aircraft, missile and space vehicles is now being used by West Coast aircraft manufacturers. Magnaflux Corporation's new Bondcheck system is said to detect lack of braze, excessive braze, deformed core and other irregularities faster and cheaper than conventional methods now used. The process locates and permanently records irregularities, indicates direction of ribbon flow directly on honeycomb panel and is used automatically.

Sandwich skin is spray-coated with a heat-sensitive fluid. When the coated surface is heated, the fluid is repelled from the warm areas of the skin, coalescing in cool areas where heat is drawn from the skin by core metal brazed to the skin's underside.

Drying quickly as heat is continued, the coating

Chicago Bridge & Iron uses supervoltage radiography for routine weld inspection

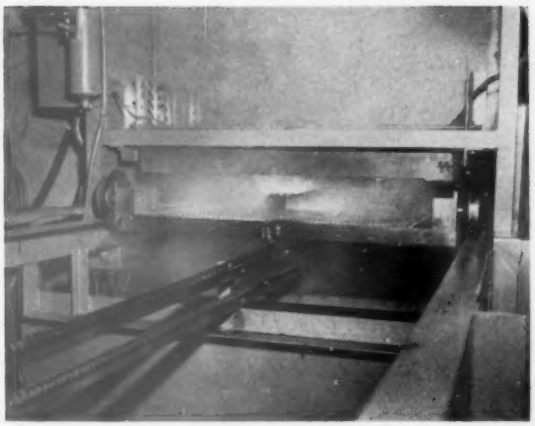


BIRMINGHAM, ALA.: Chicago Bridge & Iron Co. uses two super voltage radiographic X-ray generators for routine weld inspection. Both of these are Van de Graff X-ray generators made by High Voltage Engineering Corp.

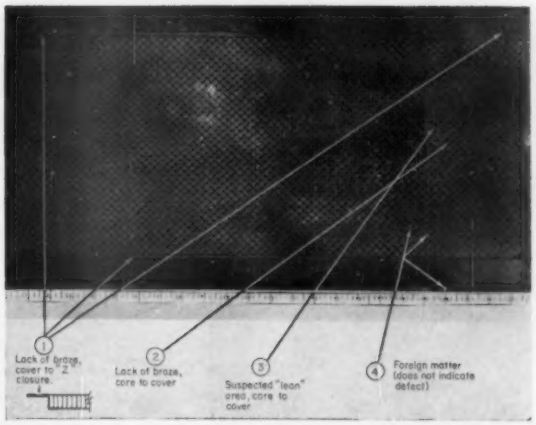
The two X-ray generators are installed in a large (35 by 120 foot floor space) concrete building.

The first unit (above, right) is a two-million volt machine. It is flexibly mounted on a traveling crane for inspecting longitudinal seams of steel thicknesses up to 10-inches. The unit is also useful for inspection of thick girth seams of high pressure boilers. By placing the target of the two-million volt Van de Graff along the axis of the boiler and in line with the girth seam, the complete 360° seam can be radiographed in a single exposure. This saves considerable set-up time.

The second machine is a one-million volt Van de



PANEL comes through infra red heating oven where heat-sensitive fluid is heated and dried.



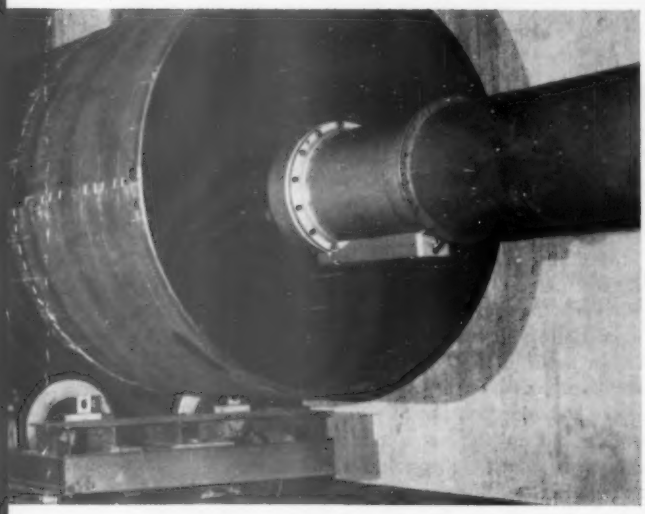
TYPICAL DEFECTS exposed by new process are shown on this 12 x 24-inch stainless steel panel brazed with nickel-boron.

fluid assumes an opaque color along lines of concentration, giving a visual display of core contact (or lack of it) with the skin. Patterns are clear-cut, permanent (but they can be removed easily with commercial solvents), and can be photographed.

Magnaflux officials say Bondcheck can process over 1600 square feet of panel per hour compared to about eight square feet with presently used ultrasonic equipment and about six square feet by conventional X-ray.

Capital investment is claimed to be a third that of other systems now available.

Material and labor costs are reduced by more than 80 percent. Total cost of material and recording film is about 17½ cents per square foot. • •



Graff mounted on a 43-foot boom (above, left) This machine is useful for inspecting girth seams of boilers with steel wall thicknesses from ½ to 5½ inches. This machine also permits girth seam inspection in a single exposure. The boom permits inserting the one-million volt unit into very long boiler fabrications. Chicago Bridge & Iron uses this supervoltage unit in preference to the conventional lower voltage X-ray machine because exposure times and set-up times are reduced. • •

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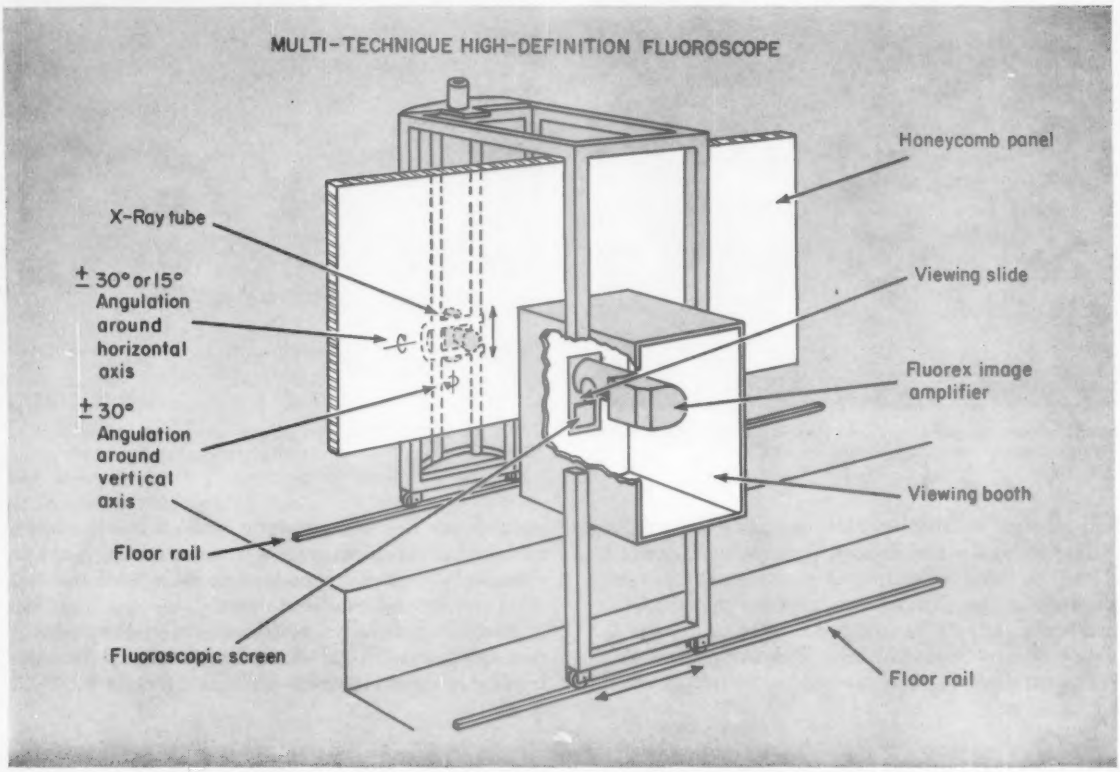

High definition fluoroscopy checks brazed honeycombs

BALTIMORE: Next to radiography, high definition fluoroscopy presents the most informative picture of the interior of a honeycomb panel, according to Westinghouse's X-ray Dept. In one respect, according to the department, fluoroscopy is a technique superior to radiography: It presents several projections of the same area as the part moves through the X-ray beam, revealing detail which may be covered up in a single view. Contrast sensitivities in the order of 2-4% can be obtained depending upon the skins and section thicknesses and up to 45 mesh wire screens can be resolved.

For best possible results with a given high definition fluoroscopic system, work handling, X-ray protection and operator viewing must be designed as a unit, according to Walter Hampe, testing consultant. Proper viewing position, surrounding conditions and human-engineered controls must be a part of the entire system in order to ensure that the inspector will work at maximum efficiency. In the following system the inspector becomes a part of the inspection apparatus.

MULTI-PURPOSE TECHNIQUE

In this fluoroscopic system the inspector rides in a protected cab. He does not sense the horizontal motion, since the speed of the scan would be 5 to 10 fpm maximum. With this system all tube angulations can be made with the X-ray beam always aimed at the screen area. The operator is protected. The Fluorex image amplifier is installed on a counterbalanced slide so it can be exchanged at will with a fluorscopic screen protected by a lead glass window. Or a radiograph can be made through a film insertion door in the slide. In addition, a TV camera can be attached to the Fluorex image amplifier to be viewed outside the room. Or, a 16 or 35 mm camera can be put in the same position for still or cine studies. A photo fluorographic device can be added to replace the fluroscopic screen-protective window combination or can be added to the counterbalanced slide system.

Inspection marking systems can be of various types. These include remotely-controlled paint sprays, a coordinate system with respect to one end of the panel, application of gummed numbers and manual marking through a suitable cabinet port.

The versatile inspection system can also be adapted to inspect longitudinal welds on pressure vessels and pipes 20-inches in diameter and up, with wall thicknesses of 3/8-inch. For steel wall up to 3/8-inch thick a sensitivity of 3% can be achieved. • •

"Baltospot is lightweight—the only completely portable 140-kv unit on the market. Ideal for inaccessible places."

E. E. Ellis says, "There's nothing to it. This unit will radiograph steel up to 1¾ inches thick."

"In less than a day I could teach anyone to make good inspection X-rays with BALTOSPOT,"

E. E. Ellis

J. B. Fisher

says E. E. Ellis, Welding Engineer and Radiographer, Fisher Tank Company, Chester, Pennsylvania. "One year of experience with Baltospot X-ray equipment proved to us that practically anyone can make good radiographs. There are just three simple steps:

1. measure thickness of part and refer to chart
2. make exposure
3. develop film according to chart

X-ray inspection keeps us on our toes and is far ahead of other methods."

Does Baltospot Pay?

"It certainly does," says J. B. Fisher, President, Fisher Tank Company. "We exercise better control over all phases of work, and save approximately 77 percent in radiography costs. Helping our welders maintain uniform high quality and developing new welding techniques are prime functions of this, the most effective means of testing welds."

Your Westinghouse X-ray Specialist has information on the full line of industrial radiographic-fluoroscopic equipment, or write: Westinghouse X-ray Department, 2519 Wilkens Avenue, Baltimore 3, Maryland. J-08369

YOU CAN BE SURE...IF IT'S

Westinghouse

For More Information Circle No. 71 on Reader Service Card.

Semi-automatic equipment speeds development of X-ray film at ACF

PORTABLE X-RAY tube is positioned in typical set-up inside welded tank.

MILTON, PA.: A semi-automated system of X-ray processing helps inspection keep pace with production at American Car & Foundry division here. ACF officials say a Kodak Industrial X-Omat Processor (Model A) is the heart of a new radiography system that cuts operating costs in half and eliminates inspection department bottlenecks. X-rays are used to inspect welded seams in railroad tank cars, nuclear power station shells and "skins" for a ballistic missiles.

Problem: Almost 200 feet of welds had to be inspected in 13-inch units on a typical tank. Then film had to be processed manually. It took 90 minutes to run a batch of film through processing tanks and dry them for examination. And, the film had to be handled nine times.

Solution: The new system makes film processing almost automatic; 12 minutes elapse from the time the film is fed into the machine until it drops into the receiving bin. The operator handles film just once.

How it's done: The X-Omat processes three strips of 70mm film at 38 ipm. Chemicals and temperatures

* DESIGNED TO MEASURE SHORT PULSES OF HEAVY CURRENT

* MINIMUM OF 100 AMPS & MAXIMUM OF 100,000 OVER 6 SCALES

* NO INTERRUPTION OF WELDING OPERATION

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RESISTANCE WELDING CURRENT METER

* READINGS CAN BE TAKEN MINUTES AFTER WELD COMPLETED

* CAN BE USED WITH SYNCHRONOUS & NON-SYNCHRONOUS TIMERS

* MONITORS BOTH WELDING CURRENT & TIME SIMULTANEOUSLY

A new instrument of particular interest to every Welding Engineer

The standard instrument has six ranges covering readings of 100 to 100,000 amps. The readings are obtained by the use of toriods which can be split and placed around the heavy current conductor. Indication is stored enabling readings to be taken minutes after the weld is made.

Can be used with welders employing synchronous and non-synchronous and energy storage controls. *Full details and illustrated leaflet available on request.*

HIRST ELECTRONIC LTD.
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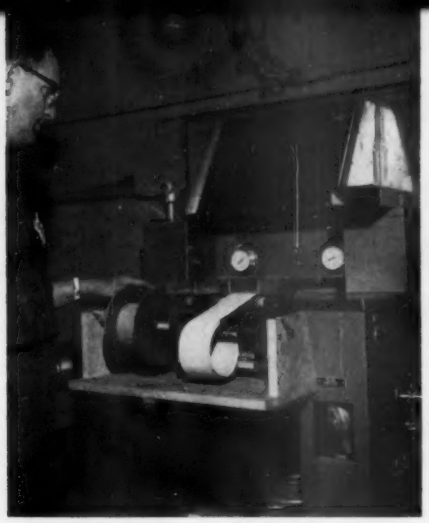
ENGLAND

For More Information Circle No. 33 on Reader Service Card.

AT CONTROL PANEL, X-ray foreman, sets dials for exposure.



X-RAY FILM is fed into processor. This is the only time operator handles the film.

COMPLETED RADIOGRAPH is examined.

are controlled automatically. As a result, darkroom work requires only 10 percent of the time formerly needed.

Major cost and time savings have been made by using the system with 300 KV General Electric X-ray tubes which have 360° anodes and Kodak Type AA industrial X-ray film.

With the new tubes, ACF technicians can cover with one exposure an area which used to require 20 exposures. An entire seam can be X-rayed in one shot.

Only about half the film formerly used is now needed. And the radiographic quality is better. Film savings are estimated at several hundred dollars a day. And, because longer film strips are used, set up and exposure time of tank X-rays is down a full 50 percent.

ACF officials estimate that the X-Omat unit and other new equipment will be amortized through operational and material savings in less than two years. • •

HI-AMP IS COOLER

HI-AMP ELECTRODE HOLDERS, CABLE ATTACHMENTS AND GROUND CLAMPS NOW OFFER T. P. C.*

***THREADED POWER CONNECTION** uses the pressure of threads on a sleeve to drive the ends of any welding cable down into a welding socket, locking it in place with threaded plugs. T.P.C. assures an excellent electrical connection and provides a direct contact between the cable and the accessory so maximum heat is conducted into the heat-absorbing cable. T.P.C. eliminates the loose or oxidized mechanical connections that build up resistance and cause excessive heat in a welding circuit.

Shown in the "cut-away" picture above is an electrode holder with the new Hi-Amp T.P.C. connection. T.P.C. can be adapted to ground clamps and quick-disconnect plugs, as well as to electrode holders.

Write for FREE Booklet, "Reducing Welding Cost"

ASK YOUR WELDING SUPPLY HOUSE FOR FURTHER INFORMATION

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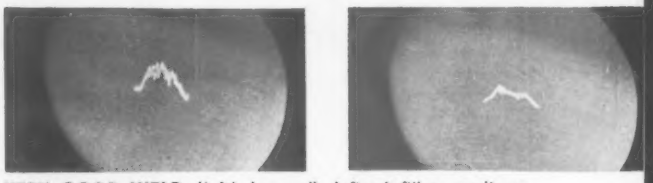
For More Information Circle No. 41 on Reader Service Card.

Ultrasonic testing checks spot weld quality

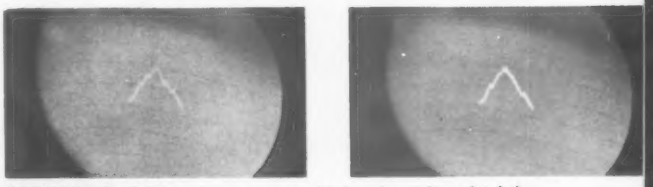
FORT WORTH, TEXAS: Ultrasonic inspection is being used to check the strength and quality of spot welds, a field in which very little nondestructive testing procedures had existed. According to Frank B. Self, vice president of Pioneer Industries, General Electric had been using the company's ultrasonic bond and braze quality analyzer, the Coinda-Scope Model 101A, to evaluate turbine blade spot welds with excellent results.

So, Pioneer ran an intensive series of lab tests in conjunction with one of the nation's leading automobile manufacturers. The results were consistent, accurate and, at times, surprising. For instance, one series of automotive spot weld samples (superior and excellent according to the manufacturer's welding supervisors) checked out in Coinda-Scope evaluation as quite weak with a "slaggy" fillet, or nugget. When the panels were finally shear tested destructively, it was found that readings had been correct. None of the welds was of the quality originally attributed to it. • •

EXCELLENT WELD: Typical signal has chatter pattern ("hash" marks) in center, outlining clearly the weld nugget—area of strongest resistance.



VERY GOOD WELD (left) has well defined fillet; mediocre weld (right) has moderate "chatter pattern" only.



POOR WELD (left) and very poor weld, barely sticking (right).

"DURO is the coolest"*

*says Ben Ruff of Reed & Graham, Inc. "Before I had to change holders whenever the one I was using would get hot. Now, with DURO, I can weld a whole shift without the holder getting hot to my hand, even when using 5/16 in. hardfacing electrodes at high amperages."

DURO will do the same for YOU

Proved by 28 years of welder's preference

- The Duro Electrode Holder has served the welding industry since 1932. It is famous for long life, positive grip and perfect balance. All parts are easily renewed. Semi- or fully insulated. Duro is available in 250, 300, 400, 500 and 600 amperes capacity.
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THE DURO "STANDARD"

- Another feature is the square guard. It protects hands from heat and also prevents rolling and grounding when placed on a flat surface. There when you need it, is a hex key fitted into the brass core and held in place by the fiber handle for making fast cable connections.

DURO ENGINEERING COMPANY

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For More Information Circle No. 22 on Reader Service Card.

Dye penetrant inspection checks multi-pass welds

LOS ANGELES: Since this pressure vessel was designed to hold 5500 pounds per square inch, it was absolutely necessary that welds be without defects. Dye penetrant with Dy-Chek materials from Turco Products, Inc., was used to make sure each pass was sound before another pass was made. • •

CUT BEVELING TIME BY 85% on Small Weldments

PULLMAX BEVELLER

The PULLMAX Beveller can be used to bevel cut large size plates with proper table support and feeding arrangement. But where the PULLMAX Beveller really pays off is in small segments difficult to bevel cut by burning and grinding.

Bevel small plate in both straight and mild radius shapes at speeds up to 11 ft. per min.

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A	1 Cut	Mild Steel	½"	1"
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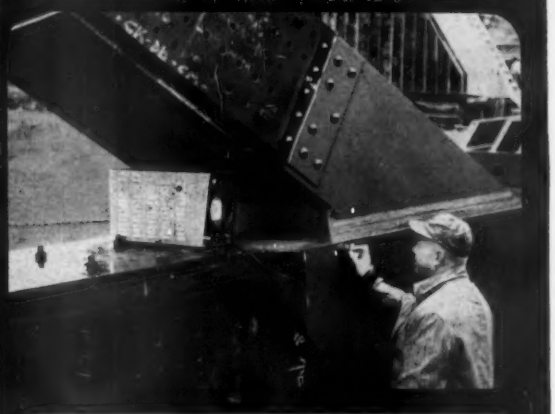
PORTABLE PRECISION IN ULTRASONIC WELD INSPECTION



THE NEW BRANSON SONORAY® MODEL 5

for inspection of raw materials going into weldments, as well as of the finished weld itself, goes with you to the job wherever it may be . . . brings laboratory precision into the field and permits the most accurate evaluations of internal structure possible today. Simplified controls, easily mastered by non-technical personnel, are centralized on the front panel. Skilled service by factory-trained specialists is always available across the nation.

PORTABLE: Weighs only 37 pounds complete.

SENSITIVE: Detects all cracks; instrument response adjustable to suit exact quality requirements of any job.

PRECISE: Completely locates, and determines extent of, internal discontinuities.

ECONOMICAL: Costs $2750.

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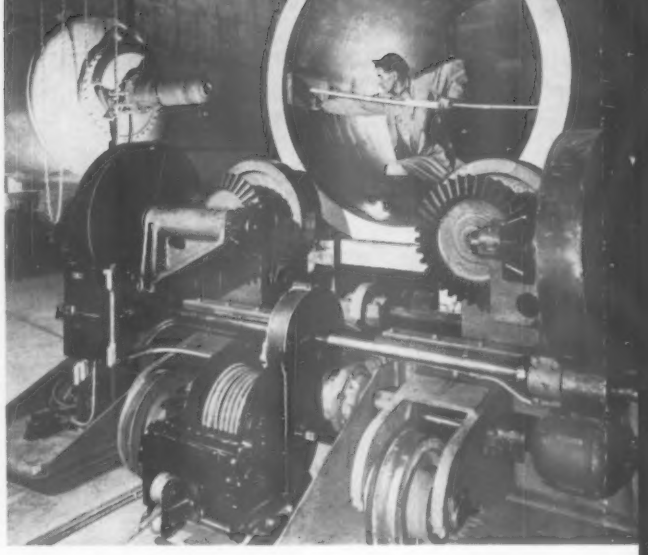

Two-million-volt X-ray unit checks welded boiler shells

BARBERTON, OHIO: A General Electric two-million volt X-ray unit (Resotron) is used to check welds on a steel boiler shell at the Babcock & Wilcox plant here. The unit in the foreground is a special mechanism B&W uses to rotate the boiler shell so all welded seams can be X-rayed. • •

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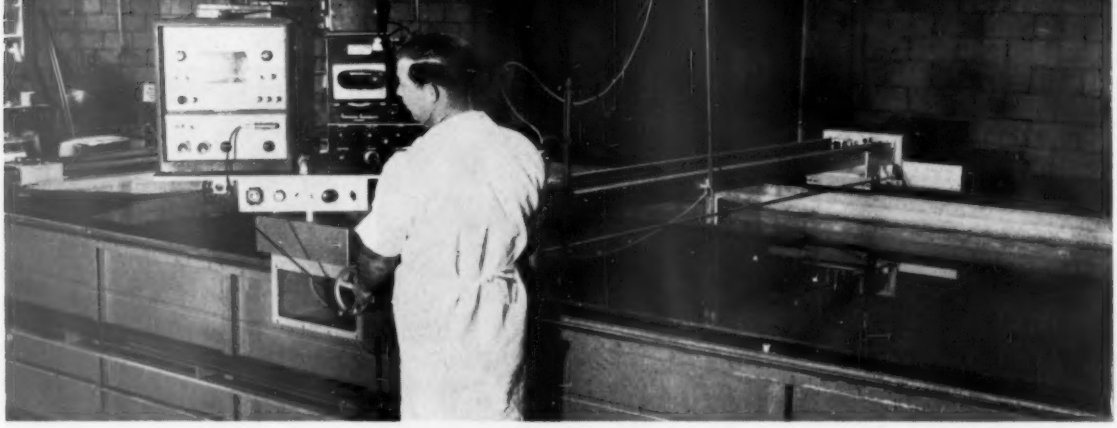

Convair inspects titanium welds ultrasonically

LOS ANGELES: Ultrasonic inspection is used by Convair (Astronautics) Division of General Dynammics Corp. to check welds in pressure vessels (helium storage bottles for the Atlas ICBM) made of 6A1-4V titanium. Equipment furnished by Automation Instruments, Inc., was used: an Immerscope coupled to an Ultragraph Recorder.

The Immerscope produces electrical pulses which are converted into mechanical vibrations by a crystal. These vibrations are introduced into a material to be inspected through a suitable couplant (water or oil). The mechanical vibrations (sound waves) travel through the material until they strike an interface or sound interruption when they are reflected back to the crystal and are retransformed into electrical pulses. The resultant electrical pulses are recorded on a cathode ray tube. Flaw is measured on the tube.

The Immerscope plots the ultrasonic indication of defects in a maplike picture on a cathode ray memory tube. Certain areas of the pattern can be eliminated or gated out, and the tube presentation can be photographed. The resultant picture is much like a radiograph in that actual size and shape of flaw can be seen and interpreted. • •

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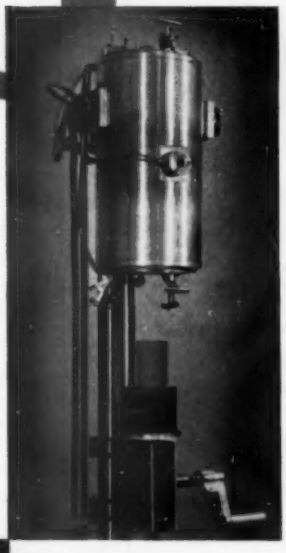
CURTISS-WRIGHT RESISTANCE FURNACE

These resistance furnaces, designed for high temperature materials testing, can be operated continuously to 4800° F and intermittently to 5100° F. Compact graphite heating elements permit unusually large working chambers with small exterior-shell dimensions.

The units are water cooled. Atmospheric control in the working chambers is provided by a flow of helium or other inert or reducing gas.

The furnaces can be supplied with either manual or automatic control. With manual control, an optical pyrometer is used for viewing the interior of the furnace.

Descriptive literature is available on request.



Model	Volume	Control
1A	8" x 4"	Manual
1B	8" x 4"	Auto.
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RADIOGRAPHIC TESTS like X-ray inspection in shop (left) and gamma inspection in the field (right) are the first step.

4 Things to know about interpreting

by ARNOLD GREENE,
president, Arnold Greene Testing Labs, East Natick, Mass.

IN BRIEF: An expert in weld radiography explains in detail how to use equipment, darkroom techniques and how to interpret radiographs.

THE USE OF RADIOGRAPHY for detecting flaws in weldments isn't mysterious anymore. But, the interpretation of radiographs still teeters on the brink of the unknown.

For 20 years men have worked out standards of comparison for use in interpreting radiographs. But, incompetents still reject much good work because they are not qualified to interpret radiographs.

It pays to have trained interpreters. Everyone will agree on that. But few know how to train them. These, I think, are the steps to take.

ABOUT THE AUTHOR: Arnold Greene a native of Boston, Massachusetts, and was educated in Cambridge. He belongs to AWS, SNT, ASTM and AMS. Mr. Greene is a consultant to a number of firms doing work in the atomic energy field and space programs and has been associated with the radiographic testing industry since the end of World War II.

DARKROOM TRAINING

Learn to load and process film. This will help you understand why certain blemishes sometimes show up on films. You'll soon get acquainted with static, developer stains, fogged film, film clip stains, mottling and other darkroom defects.

When you have time, study darkroom techniques. Helpful pamphlets available from film manufacturers describe the results of improper developing.

When you have finished darkroom training and have started to make radiographs, you will have learned that carefully made radiographs can be spoiled by poor processing. Faint images of defects can be obscured. You can mistake a shadow of a line from a streak for lack of fusion. These and many other supposed defects could cause you to reject sound welds.

USE OF EQUIPMENT

Your training in the use of X-ray machines and gamma isotopes should be even more extensive than your darkroom training.

It's not enough that you know how to push buttons, grind out a source, or understand why you are using 100 KV instead of 200 KV.

You should learn to look at the corners of the film cassette for pin

RADIOGRAPHIC FILMS must be developed and interpreted by trained personnel.

radiographic film

holes that would let light leak to the film. And, you should know that cracks in lead shielding screens will show up as cracks on film, but there is none in the weld.

And, you should learn that putting heavy objects on a film cassette will leave a defect on the processed film which might lead you to reject a good weld.

There are many other mishaps that produce radiographs which might cause you to reject a good weld. But, you can learn to avoid them and to detect them with training and experience. The training you can get from many good text books. But, you can only get the experience by practical work.

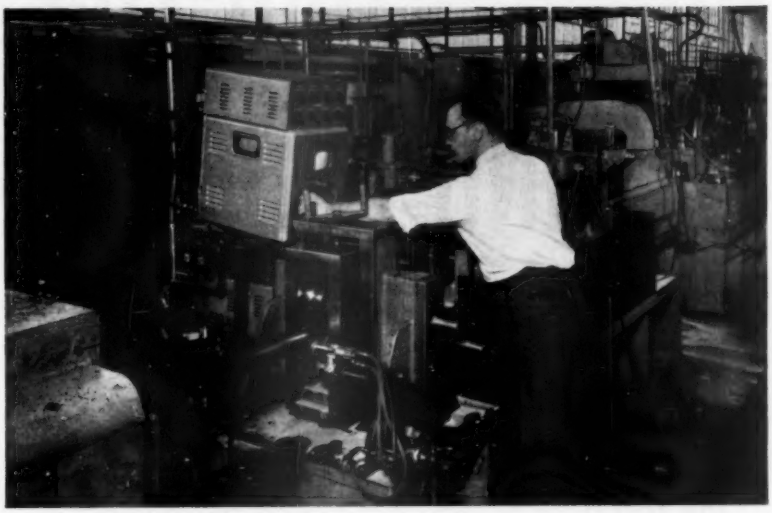
SORTING FILM

This sounds like a job you can give to anyone in the radiographic department. But, it isn't. It's your first step in learning to interpret film. In this job you can see the same defects day after day. Natural you'll have someone explain to you and define for you the images of the various defects. This will be your springboard to learning to interpret radiographic films.

INTERPRETING RADIOGRAPHS

You should start to read radiographs under the watchful eye of an experienced radiologist. In fact, the best way is for you to look over the

AUTOMATIC WELD INSPECTION ON CONTINUOUS PRODUCTION LINE



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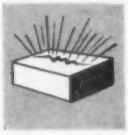

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shoulder of an experienced interpreter.

You should have comparison standards available to help you interpret weld radiographs. Study these every chance you get. These will tell you what the size and quantity of the various defects mean.

One good set of standards is available from the American Society for Testing Materials. These are index cards with attached films that illustrate various weld defects. These cards are often used as a set of standards by a purchaser and a vendor when special standards are required.

All the same, you should get instructions from an experienced person besides using comparison standards.

SUMMARY

This training program is simple: many companies have used it to train people to interpret radiographs properly.

Just remember, even experienced welding men sometimes have never developed a radiographic. Some have never been connected with a radiographic laboratory. Many do not recognize these weld defects: slag inclusions, gas holes, incomplete fusion, lack of penetration, and others. Some don't understand the radiographic set up. This means they would reject certain indications which are elongated by geometry yet are within limits of acceptance.

And, many skilled welding men do not know enough about penetrameters. These devices are used to determine detail and contrast sensitivity of a radiograph. They are important to anyone who interprets weld radiographs.

A good viewer is another important piece of equipment. High intensity viewers are becoming popular. The viewer with the iris diaphragm seems to be the most popular. You need brightness control, too.

Radiographs are made in an H & D density range of 1.5 to 3.5. Some of the isotopes tend to produce unsharpness in radiographs, so you must expose in the 2.5-plus density range. You must have a high intensity viewer to study these films. • •

HARD FACING

continued from page 22

and the Kenface tube melted onto the surface with an acetylene-rich (2½ to 3 times) reducing flame.

WELDING STAINLESS FOIL

continued from page 31

welding already exists in the AWEC longitudinal welding fixture. It can fusion butt weld 0.005-inch stainless steel sheets.

The hand screws position copper-tipped hold-down fingers uniformly on either side of the seam. The automatic model will have a vernier adjustment for this. A screw jack accurately positions a removable mandrel carrying a copper back-up bar. The bar is drilled to feed inert gas to the underside of the weld.

The operator puts in one sheet of foil and aligns it for welding. He positions the hold-down fingers as close as possible to the edge of the foil. Then they pneumatically clamp the work. He snugs the second sheet of foil against the first and clamps it. The clamping forces the edges together, upsets them slightly. This aids welding because it compensates for slight inaccuracies in the edges.

The TIG welding head mechanically travels on a polished steel guide bar. The arc starts easily, because high frequency current is imposed on the tungsten electrode.

The guide bar is very accurate, Russell explains. In 36 inches of welding-head travel the arc voltage won't fluctuate more than ¼ volt, and the weld won't veer more than 0.001 inch from a straight line.

The positioning of all hold-down fingers at once has reduced set-up time. An older (10-foot) fixture with individually set fingers took two hours to set up. The new one can be set up in three minutes.

Foils as thin as 0.001 inch have been butt welded experimentally; 0.0015-inch stainless steel has been butt welded on a production basis. For some time the aircraft industry has been joining 0.005 stainless sheets in 17-7 PH; AM-355; and 15-7 Mo. They are currently butt welding stainless foil in lengths up to 16 feet, 3 inches.

As expected, hold-down pressures, gas flow, welding speed and voltage must be regulated exactly in joining foil.

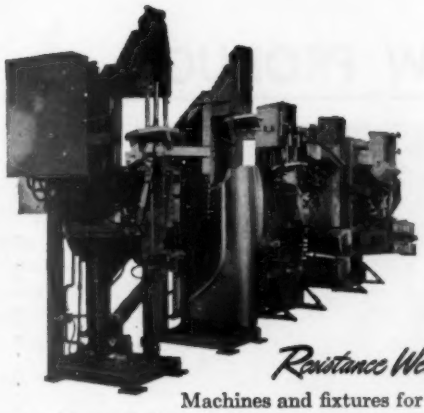
Particularly critical is dissipation of heat. The general rule is to locate the copper hold-down fingers as near to the seam as is possible. To make, for example, a 0.015-inch weld in 0.005-inch stainless foil they put the fingers 0.030 inches way.

The copper back-up bar feeds inert gas to the underside of the weld through 0.040 holes, 1 inch apart.

Foil welding usually calls for an argon purge of both sides of the weld. Sometimes argon is used torch side and helium underside. Other conditions, however, may call for the reverse.

Resistance lap welding lost out to fusion butt welding for certain work. The best aerodynamic surface for airplanes and missiles is a smooth one. It takes extreme skill to get a smooth surface with lap-welded joints—especially if the sheet must be contoured to fit an irregular honeycomb core. Besides, when lap welds break, the damage is usually concealed. In contrast, butt welded sheets with planished welds are perfectly smooth. Also, a weld failure stands out.

According to Russell, there aren't many weld failures. The weld forms right along with the parent metal in shaping to irregular contours. • •



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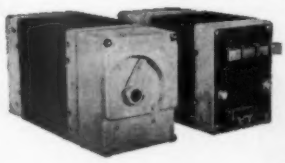

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NEW PRODUCTS

Stud Welding Power

A new silicon rectifier welder designed specifically as a power source for Nelson stud welding equipment is available from the Westinghouse arc welding department and Gregory Industries' Nelson Stud Welding Division. Supplied from a 3-phase, 60-cycle, 230- or 460-volt a-c source, the new Surge Arc power source provides direct current for welding studs through 5/8 inch diameter to steel or aluminum.

Current delivered by the welder is appropriate for welding studs ranging in diameter from 3/16 inch through 5/8 inch. Matching output level to the job is done by turning an eight-position dial to the proper setting, and can be paralleled. With adequate incoming power and suitable cables, two paralleled units will weld Nelson granular-flux-filled studs one inch in diameter.

Circle No. 80 on Reader Service Card.

Portable AC Outfit

A new high-output, low-cost M&T Murex AC arc welding outfit announced by Metal & Thermit Corp. will weld metals up to 1/4-inch using 1/16- to 1/8-inch electrodes. With an auxiliary torch, the unit can be used for brazing, soldering, heating and bending.

Designated Model M9T, the outfit consists of the transformer unit, welding cables, adjustable helmet, flux, holder, ground clamp, starting carbon, aluminum and steel electrodes, bronze brazing rod and an operating manual. An arc torch is available.

The welder weighs 49 pounds. The transformer uses double glass insulation on both primary and secondary windings and operates from a 110- or 220-volt AC source. Welding current range is 20-95 amps.

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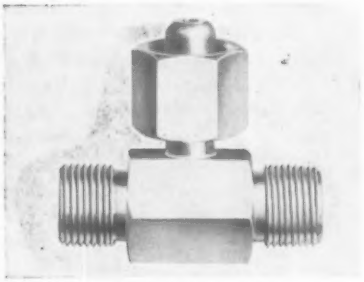

Oxygen Coupler Tee

A new, special brass fitting, oxygen coupler tee #T-62—permitting use of two oxygen regulators with one liquid oxygen cylinder, or with pigtail assemblies on manifolding cylinders—has just been announced by Western Enterprises, Inc.

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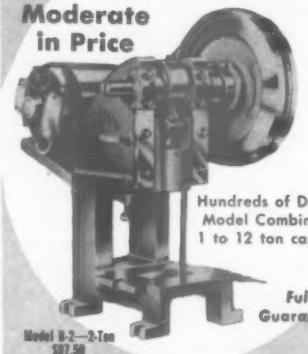

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Ultrasonic Flaw Alarms

Three new flaw alarms for electronic monitoring are now available as accessories for Sonoray ultrasonic pulse-echo flaw detectors built by Branson Instruments, Inc. These alarms let the operator pay closer attention to materials under test. He refers to the Sonoray screen only when evaluating defects noted by the alarm.

All three flaw alarms have two outputs in common: a red defect-indicator light mounted on the Sonoray front panel and a 5 v DC (no-load) signal which will trigger audible alarms or markers, or start corrective action.

The Model A flaw alarm, a pass/reject indicator, consists of the two standard outputs, panel light and DC signal.

Model B also has variable DC output, proportional to size of flaw and the signal in the alarm gate of the cathode-ray tube. When connected to a pen recorder, Model B logs the amplitude of any defect above a preset discriminator level.

Model C flaw alarm is recommended for high speed scanning. It permits recording of flaws at the pulse repetition rate which may be varied by the operator, from 100 to 600 pulses per second in the standard instrument. With suitable preamplifiers and data plots, Model C provides a permanent record of all defects found.

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Air-Cooled Holder

An air-cooled electrode holder for heavy-duty arc welding has been developed by J. B. Nottingham & Co., Inc. It will hold electrodes through 3/8" diam and is rated 600 amps at 40 volts and 60% duty cycle.

The air-cooled unit is said to let

a man weld a full shift without changing holders, and to eliminate the hazards and complications of water cooling.

Air at low pressure flowing from perforations in the handle cools the

holder and the operator's hand. The holder is the lever-action semi-insulated type with straight jaws as standard equipment and offset jaws available on order. The complete unit includes a 6½-foot Neoprene-encased cable whip and a "Y" connection with air inlet brazed into a Cam-Lok twist-and-lock electrical connector.

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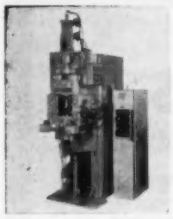
Magnetic Force Welder



A magnetic force welding machine for making full area percussion welds has been introduced by Acro Welder Mfg. Co. Designed for welding silver alloy relay contacts in motor starters, the unit can be adapted to many operations that require joining non-ferrous metals. Designated Acro-Magnetic Model APPAMFP-1-100-12, the unit is a 100 KVA magnetic force projection and spot welding machine with DC holding coil delayed forge, diaphragm safety head and selective micro-switch firing features.

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Brass and steel valve bodies are brazed quickly and easily with a new production line setup devised by Induction Heating Corp. The company's Model 750 Ther-Monic induction generator will braze two brass parts every 40 seconds and one steel part in 30 seconds. A single work coil takes three sizes of assemblies.

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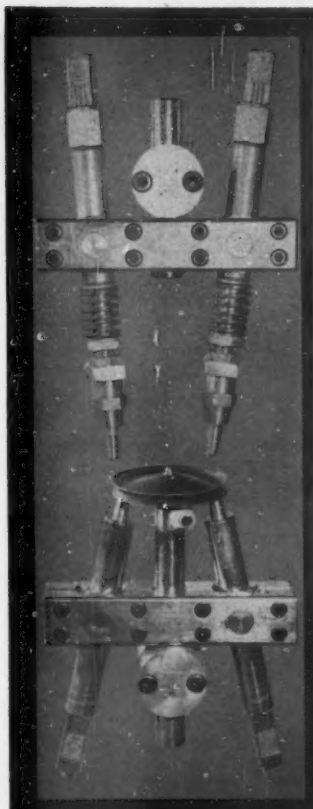

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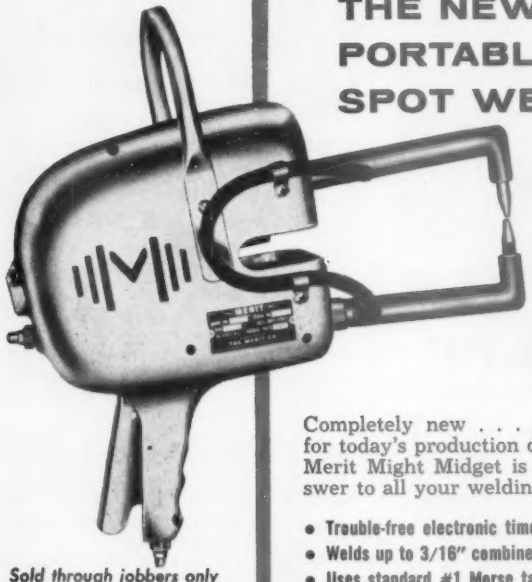

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Ultrasonic Flaw Detector

A new ultrasonic flaw detector developed by Sperry Products, Inc., is compact and lightweight and is suitable for both contact and immersed inspection. The UI Reflectoscope can be mounted directly on scanning bridges now in use.

Features include a 12-inch dual trace tube that is bright enough to be seen from a distance and a two-color display that lets flaw indications be easily distinguished from range marks. There are four fast-acting flaw gates with separate channel indication for signaling the presence of flaws or reduction of back reflection. The four channels are broadly adjustable.

The UI Reflectoscope contains double slope distance amplitude corrections controls that compensate for both near field effects and attentuation in the material.

Frequency ranges run from 1.0 to 25.0 megacycles.

The calibrating circuit shows the action of the distance amplitude correction curve on the CRT screen. The repetiton rate is variable from 200 to 2000 pps.

The UI has the necessary video and signals for driving an external B-Scan.

Circle No. 85 on Reader Service Card.

Creep Testing

A new line of stress-rupture-creep testing machines has been announced by the Tinius Olsen Testing Machine Co. Available in two models (140- to 6,000-lb. or 280- to 12,000-lb. capacity), ruggedly built units are designed for uniform load application for longer periods. Testing temperatures are maintained to within plus or minus 2°F by an integral thermostat.

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Circle No. 65 on Reader Service Card.

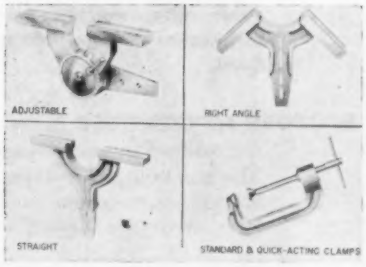
Honeycomb Inspection

An "inexpensive, quick and completely satisfactory" method of inspecting brazed metal honeycomb sections has been developed by Picker X-Ray Corp., it is reported by Picker's industrial representative, John Leask. Inspection methods previously developed have been inadequate, time-consuming and expensive, he said.

"Research by Picker has led to the development of a photo-fluorography technique that gives the required sensitivity (3 percent), adequate speed (145 square feet an hour on a 4-inch panel thickness), moderate initial investment and low operating costs," Leask reported.

In operation, he explained, an X-ray head and a detector move across the structure being inspected —eliminating the problem of moving the structure—and automatically "scan" the entire unit, exposing in rapid sequence 16 inch square sections (when used on ¾-inch thick panels). Each of these projections on a fluroscopic screen is automatically recorded by a camera and the film is ready for inspection in minutes, he said.

Circle No. 87 on Reader Service Card.



Work Holders, Clamps

A new line of work holders and clamps for short run welding, soldering and brazing operations has been introduced by Wales-Strippit, Inc., a unit of Houdaille Industries, Inc.

Three different work holders are available: *Adjustable*-clamping faces can be set at any angle from 0° to 180° by calibrated dial and single, quick-lock handle. *Right angle*-clamping faces permanently fixed at 90° angle. *Straight*-clamping faces aligned to in-line butt joints. All holders can be combined to make almost any pattern of 2-way or 3-way joints.

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Circle No. 5 on Reader Service Card.

REFERENCE DATA *catalogs, handbooks, manuals*

A NEW PANTOGRAPH-TYPE flame cutting machine is the subject of Form ADC 899 issued by Air Reduction Sales Co. to introduce its new Linagraph machine. The catalog discusses in detail the design, construction and operation of the machine which can be used for straight line and shape cutting on eight-foot steel plate used in medium duty production. **For More Information Circle No. 100 on Reader Service Card.**

PRECISION ELECTRONIC welding equipment marketed by Weldmatic Division of Unitek Corporation is featured in 4-page, short-form catalog. It contains descriptions, design and performance features, prices and illustrations of all Weldmatic stored-energy power supplies, column-mounted weld heads and light- to heavy-duty hand pieces. **For More Information Circle No. 101 on Reader Service Card.**

"CIRCOMATIC" WELDING EQUIPMENT made by Arcos Corp. is the subject of a new, illustrated 4-page folder. The bulletin describes how this new process is used for automatically welding girth seams on tanks. It explains how this new process utilies visible arc, CO_2 shielded welding apparatus supported by a "saddle-bag" cab which rides around the top edge of the tank plates quickly making a continuous weld. **For More Information Circle No. 102 on Reader Service Card.**

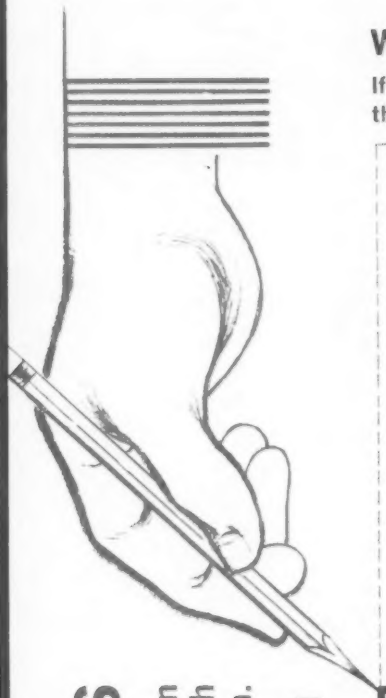
WELDING CABLES and welder power supply cables are the subject of a 6-page folder issued by General Cable Corporation. The folder discusses the advantages of cured-in-the-mold neoprene jacketed cables with copper conductors and the economies of the rubber jacketed copper and aluminum conductor cable. Tables, which include the cable sizes, weights, package lengths, and IPCEA ratings, are included. **For More Information Circle No. 103 on Reader Service Card.**

FACTORS TO CONSIDER in the selection of steel blast cleaning abrasives are outlined in new 20-page Booklet 2294 issued by Pangborn Corp. The non-technical booklet describes and illustrates the latest metallurgical developments applied in the production of steel shot. **For More Information Circle No. 104 on Reader Service Card.**

71-PAGE illustrated "Guide to Better Welding" issued by J. B. Nottingham & Co., Inc. explains the principles, uses, and advantages of multi-arc welding. The publication compares initial operating and maintenance costs of multi-arc and single-operator welding. Applications of multi-arc systems to tungsten arc, consumable Multi-arc equipment are described. **For More Information Circle No. 105 on Reader Service Card.**

LIQUID-TO-GAS EQUIVALENTS are given on a handy 8½ by 11 inch wall chart prepared by Ronan & Kunzl, Inc., The chart shows at a glance the gaseous equivalents of from one through 5000 gallons of liquid oxygen nitrogen and argon. It shows the cubic feet of gas available when liquid is converted to gas. The approximate equivalent number of high pressure cylinders is also shown. **For More Information Circle No. 106 on Reader Service Card.**

FACTS AT YOUR FINGERTIPS: *If you want copies of the catalogs featured on these pages, just circle the appropriate numbers on the bound-in Reader Service Card. We'll do the rest.*



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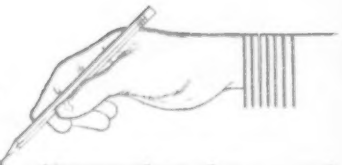

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A NEW CABLE CONNECTOR with patented locking action is described in a brochure from Ampco Metal, Inc. Illustrated Bulletin W-32 explains the offset design of the new connector and points out some of its other advantages: no overheating nor arcing; no springs, catches, nor snaps; no moving parts.

Circle No. 107 on Reader Service Card.

AUTOMATIC REELS for hose and cable are described and illustrated in a new catalog folder from United Specialties, Inc. Styles and types of reels are shown for single and dual hose and cable applications.

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EDUCATIONAL X-RAY CHART from Philips Electronic Instruments shows 10 basic X-ray techniques used for industrial quality control and scientific research. The 11½ by 22 inch wall chart shows a simplified diagram for each of the techniques with explanatory notes and discussion of applications.

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PRESSURIZED METAL SPRAY guns made by Metallizing Company of America, Inc. are the subject a new, fully illustrated brochure. Complete information is given on the company's new Powder Jet guns and their various industrial applications.

Circle No. 110 on Reader Service Card.

"PIPE THAWING with Miller" is the title of a timely, interesting and free folder from Miller Electric Mfg. Co. Line drawings illustrate detailed instructions which include amperage settings and recommended cable sizes.

Circle No. 111 on Reader Service Card.

STRUCTURAL WELDING MANUAL is offered by Saxe Welded Connections. The comprehensive 68-page book covers all phases of structural welding and explains in detail how the company's connection units (seats and clips) are used in welded assemblies.

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A VERSATILE LINE of poratble resistance welders is the subject of Brochure G-59 issued by Federal Machine and Welder Co.

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For More Information Circle No. 58 on Reader Service Card.

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For More Information Circle No. 53 on Reader Service Card.

ACTIVE METALS *continued from page 30*

chambers, but manual welding is usual.

To weld active metals successfully you have to be familiar with such metallurgy as effects of impurities in the base metal and those absorbed during welding. Most of the active metals are fusion weldable in the weldable grades with the right filler metal.

You use the same welding techniques for most metals; change only when complications arise. For example, if you get weld metal cracking you preheat or postheat; or perhaps you only change the speed of welding. It is often difficult to find the cause of weld defects, especially when you have only a small quantity of an expensive metal to experiment with.

When you plan to fabricate an unfamiliar metal, you should tests its weld properties, and if equipment is available, test it at various temperatures. This will give you assurance that undesirable changes do not occur in your temperature range.

You should take utmost care in cleaning all dirt and grease from the metal. Where sulfur is harmful, your jigs, fixtures, welding rod and torches must be clean. Their dirty surfaces give off fumes that contaminate the weld metal. Poor quality filler metal adds impurities in the molten pool. This causes more cracking and porosity.

You also need high purity inert gases to avoid weld contamination. • •

These are typical welding chambers . . .

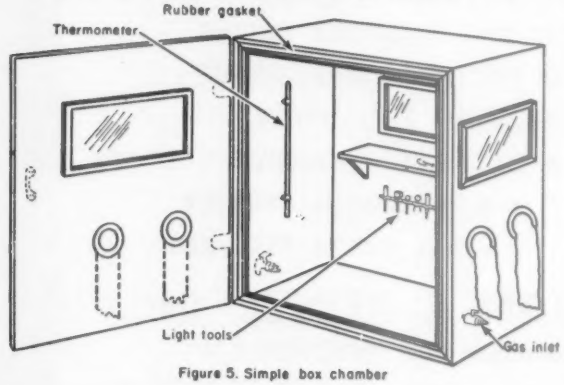


Figure 5. Simple box chamber

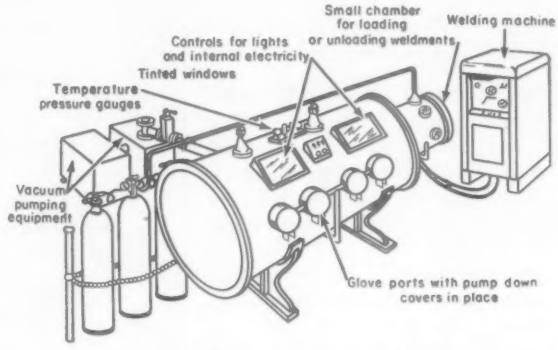
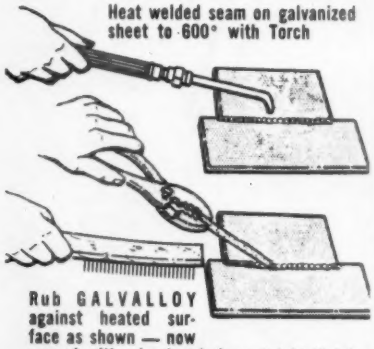

Small chamber for loading or unloading weldments
Welding machine
Controls for lights and internal electricity
Tinted windows
Temperature pressure gauges
Vacuum pumping equipment
Glove ports with pump down covers in place

Figure 6. Elaborate production chamber

No Other Product Can Do a Galvanizing Job Like

Galvalloy

Does - *HERE'S PROOF*


Heat welded seam on galvanized sheet to 600° with Torch
Rub GALVALLOY against heated surface as shown — now spread with wire brush for a bright finish.

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IN 1936, MORT CLARK, then Vice-President of the world's largest sign manufacturer, wanted a welded galvanized sign frame. Every welder manufacturer said it couldn't be done . . . Mort Clark did it, received a check and certificate of achievement from the Lincoln Welding Foundation—and

MORT CLARK'S **GALV-WELD** ALLOY ORIGINAL & GENUINE

WAS BORN

The Navy didn't believe, tested it 3384 hours in salt spray (100 hours is normal), then approved it. Westinghouse reports Galv-Weld roof sign, installed 1936—still perfect in 1959—23 YEARS LATER!

TIME PROVEN — MODESTLY PRICED
WHY EXPERIMENT?

Regalvanizes corrosive seams and areas where galvanizing is burned away by welding, skipped in hot dip galvanizing, or abraded in fabrication.

Eliminates corrosion areas produced by welding, so that weld will stand up under paint, WITHOUT rust, as on ornamental iron. Simply use residual heat from welding, or reheat, wire brush, and apply. No fluxing—No fumes.

Makes every welder a galvanizer of small weldments or parts. Repairs chipped porcelain, rusted appliances, rusted auto, truck or trailer bodies, frames, fenders, or other steel products. Can be readily refinished to match surrounding surface.

Ideal for pipe joints, galvanized structures, water and fuel tanks, duct systems, cold storage lockers, sinks, drains, washers, towers, steel buildings, railings, etc.

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Bateman Bantam with punch....$575.00
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P. O. Box 11 Pelham, N. Y.

ALUMINUM TRAILERS

continued from page 37

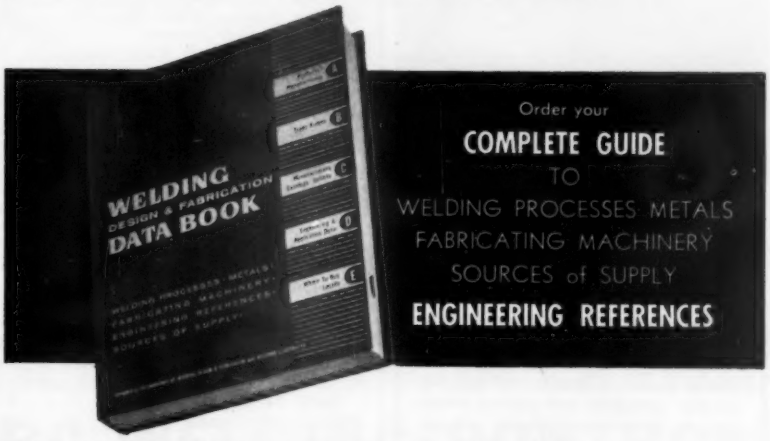
nose section (cylinder well) and tailgate, are made as subassemblies.

Assembly work is done on a platform of beams. First, the underframe is prebowed longitudinally. This compensates for warping which takes place when the floor plate is welded to the underframe. Then the remainder of the dump trailer (nose section, side panels and side braces and the tailgate) is tacked into place and welded.

Shearing: The 12-foot mechanical shear gives cleaner cuts with less burrs than an alligator-type shear.

Forming: A 25 foot press brake is used for forming aluminum up to one-inch thick (It handles steel up to 3/8 inch). The one problem Lodestar has is that it cannot get radii as sharp as those made in steel. Lodestar holds inside radii to 2 or 2½ times plate thickness; on the brittler 6061 it is three times the plate thickness. • •

931 PAGES OF VALUABLE WELDING INFORMATION



ENGINEERING AND APPLICATION DATA: Your 1960/1961 Welding Data Book contains more than 350-pages on techniques and processes for welding and fabricating all metals. It also has:

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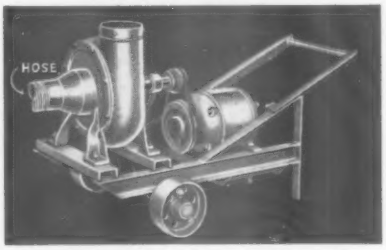

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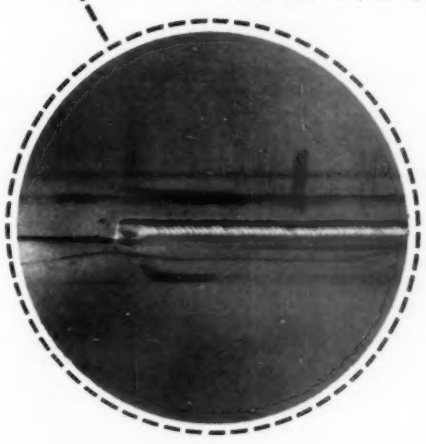

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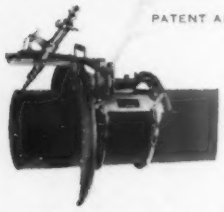

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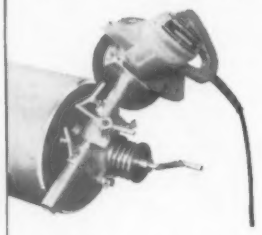

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